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OPERATIONAL AND TECHNICAL ANALYSIS GTE/WESCOM KEY/AUTOMATIC CALL DISTRIBUTOR COMMUNICATION SYSTEM, PORTLAND, OREGON, FLIGHT SERVICE STATION

Richard K. Ohman
Edward M. Sawtelle

NOVEMBER 1976

FINAL REPORT

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16. Abstract
Field test and evaluation of the Portland, Oregon, Flight Service Station (FSS) GTE/ WESCOM Key/Automatic Call Distributor Communication System (ACD) were accomplished to determine the applicability of the equipment as a system to be specified for high-activity FSS's.

The system test and evaluation were accomplished by (1) evaluation of normal facility operation, (2) conduct of scripted tests, (3) analysis of FSS specialist's responses to questionnaires, and (4) analysis of operational failure logs and equipment design.

Onsite observation of frequent circuit failure attributable to either system logic error, fabrication error, or integrated circuit chip failure led to the conclusion that the system did not function reliably and that such integrated circuit ACD systems should be given standard engineering and operational tests in a laboratory environment.

Performance of the Common Control Subsystem, as limited to the Portland FSS, generally evidenced the requisite degree of utility and service efficiency. The ACD function from the date of installation did not measure up to Preflight specialist or calling party requisites. The ACD function, on occasion, did evidence equal distribution of inbound calls to the in-service Preflight positions. The general application of the candidate WESCOM ACD is not recommended for high-activity FSS facilities.

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LIST OF ABBREVIATIONS

AC	Assistant Facility Chief (position)
a.c.	Alternating Current
ACD	Automatic Call Distributor (distribution)
AFS	Airway Facilities Service
ARTCC	Air Route Traffic Control Center
ATC	Air Traffic Control
A/G	Air/Ground (Transfer Key)
CCS	Common Control Subsystem
CMOS	Complementary Metal-Oxide Semiconductor
CO	Central Office of the servicing telephone company
COM	Intercom select key
COS	Complementary Symmetry Metal-Oxide Semiconductor
CTQ	Call Transfer Queue
CT	Call Transfer (key)
d.c.	Direct currect
EF	Enroute Flight Advisory Service (position)(specialist)
FAA	Federal Aviation Administration
FBO/EF	Fixed Base Operator/Eagle Flightways Corporation
FBO/HA	Fixed Base Operator/Hillsboro Aviation Corporation
FC	Facility Chief (position)
FD	Flight Data Position (specialist)
FET	Field Effect Transistor
FSS	Flight Service Station
FTS	Federal Telecommunications System
FX	Foreign Exchange (A central office of a nonservicing telephone company)
GA	General Aviation
GTE	General Telephone and Electronics Company
HP	Hewlett-Packard Corporation
IC	Intercom (System)
IF	Inflight Position (specialist)
IN	ACD Activation Key
IP	Interphone (system)
KTU	Key Telephone Unit
LED	Light Emitting Diode
LSI	Large Scale Integrated Circuitry
MOS	Metal-Oxide Semiconductor

NAFEC	National Aviation Facilities Experimental Center
NAVAID	Radio Aid to Air Navigation (VOR, TACAN, etc.)
NWS	National Weather Service (Transfer Key)
PCQ	Primary Call Queue
PDX	Coded Identifier for Portland, Oregon
PF	Preflight Position (specialist)
PL	Private Line
PST	Pacific Standard Time
PTT	Push-to-Talk Switch
RAD	Radio Transfer Key
RLS	(Line) Release Key
R&D	Research and Development
SEC	Secretary
SRDS	System Research and Development Service
SS-1	Selective Signaling Line
TAD	Trigger Activated Diode Switch
TT	Teletype Position (specialist)
TTL	Transistor-Transistor Logic
V	Volts
V a.c.	Volts, alternating current
V d.c.	Volts, direct current
VHF	Very High Frequency
WESCOM	WESCOM, Incorporated
WO	Weather Observer
WX	Weather

INTRODUCTION

PURPOSE.

The purpose of this project was to evaluate a candidate Flight Service Station Communications System utilizing automatic call distribution capability.

BACKGROUND.

Approximately 350 Flight Service Stations (FSS's) are located within the 48 conterminous states. A commonality of service to the flying public (General Aviation, military, air carrier, and air taxi) is applicable to each FSS. Commonality of service references three basic services: Preflight (PF), Inflight (IF), and Enroute Flight Advisory Service (EF). FSS participation in service activity is location-dependent and results in the classification of each FSS as a low-, medium-, or high-activity facility. FSS activity may be primarily generated through the provision of PF service, through the provision of IF service, or an approximate equal mix of these services.

The growth of General Aviation (GA) has had a profound impact on FSS activity, especially those FSS's classified as high-activity facilities. Approximately 50 FSS facilities are included in this category. PF service at these facilities is the dominant activity. Telecommunication equipments generally used by PF specialists do not provide the needed utility to the PF specialist staff nor the desired efficiency of service to the flying public. The Air Traffic Service of the Federal Aviation Administration (FAA), in recognition of the need to enhance the PF service and, in general, all telephonic services at each FSS, levied upon the System Research and Development Service (SRDS) a requirement for development of a ground-to-ground voice communication specification applicable to current high-activity FSS's. A prerequisite of this specification is that it include automatic call distribution (ACD) capability. Responsibility for the test and evaluation of an initial ACD was delegated to the National Aviation Facilities Experimental Center (NAFEC) by SRDS.

Several candidate systems have been built by industry which might be a basis for the specification. One candidate system, the GTE/WESCOM Key/Automatic Call Distributor Communication System (WESCOM) was installed at the Portland, Oregon, FSS, located at Hillsboro, Oregon. This system was specified by the Northwest Region, and leased from the General Telephone and Electronics Company (GTE). The onsite analysis was performed by the NAFEC team after the system was operational for approximately 3 months. Prior to this activity, no other onsite FAA or contractor system evaluation tests had been performed.

This report describes the evaluation activity conducted by NAFEC at the Portland, Oregon, FSS. The evaluation was performed as activity 063-221-020 of SRDS Communications Subprogram 063-221, "Voice Switching and Control."

OPERATIONAL SYSTEM DESCRIPTION

GENERAL.

WESCOM, Incorporated, Downers Grove, Illinois, is a supplier of telephone equipment to GTE. The Northwest Regional Office of FAA contracted with GTE to lease a basic WESCOM system modified to provide automatic call distribution service. System design is based on the use of state-of-the-art integrated circuitry components that would efficiently service and support ground-to-ground voice communication requirements (including ACD) peculiar to the Portland FSS. The system serves 15 attendant positions and has three subsystems. Subsystem identities are: (1) Common Control Subsystem, (2) Monitor Subsystem, and (3) Power Subsystem.

COMMON CONTROL SUBSYSTEM.

The Common Control Subsystem (CCS) is a switching subsystem which interfaces with the Monitor and Power Subsystems of the WESCOM system, commercial trunk systems, the local intercom system, FAA radio system and legal voice recording system, and the 15 attendant positions. Leased trunk service to the CCS is inclusive of two Central Office (CO) trunks, nine Foreign Exchange (FX) trunks, two Federal Telecommunications System (FTS) trunks, two Private Line (PL) trunks, and two Selective Signaling (SS-1) trunks. Distribution of this trunk service is outlined in table 1, "Line Termination Schedule."

The Automatic Call Distributor is a component of the CCS. From a functional viewpoint, the ACD is a second-level switching subsystem dedicated to provide equal call distribution of inbound CO, FX, and PL calls to the PF positions. The ACD is placed in service by the CCS whenever an "IN Key" (IN) on any PF telephone console has been depressed and, further, provided that a handset or headset jack has been inserted in the jack module associated with the PF telephone console, having a depressed IN key. These two requirements are, colloquially said to "condition the ACD."

All FX and PL trunks are dedicated to the PF activity. Likewise, one CO trunk is so dedicated. If the ACD has been conditioned "in service," the CCS will route all incoming calls on the dedicated trunks to the ACD and, simultaneously, to the Assistant Chief (AC) and Flight Data (FD) telephone consoles. The latter action of the CCS is to provide backup and call preemption capability. The ACD, in turn, will route the calls to nonbusy PF positions or to Primary Call Queue (PCQ) in the event that all PF positions are busy.

If the ACD can locate a nonbusy, PF position, it will alert the specialist by transmitting a Call Alert signal to his headset and to the telephone console speaker. No additional requirement, such as depressing a line key, is required of the specialist, as the ACD routes all calls from the dedicated PF trunks to

TABLE 1. LINE TERMINATION SCHEDULE - PORTLAND FSS

Positions of Operation

	FC	SEC	AFS 1	AFS 2	TT	AC	IF 1	IF 2	IF 3	EF	PF 1	PF 2	PF 3	PF 4	FD	Remarks
Central Office Lines (CO)																
648-1022	K	K			K	K				K						1
648-2111						K				K	I	I	I	I	K	2
FTS Lines (FTS)																
221-2330	K	K				K				K					K	
221-2675	K	K				K				K						
Foreign Exchange Lines (FX)																3
Aurora, Ore. 678-1391						K				K	I	I	I	I	K	
Kelso, Wa. 425-9400						K				K	I	I	I	I	K	
McMinnville, Ore. 472-6538						K				K	I	I	I	I	K	
Newberg, Ore. 538-9700						K				K	I	I	I	I	K	
Portland, Ore. 222-1690						K				K	I	I	I	I	K	
Portland, Ore. 222-1699						K				K	I	I	I	I	K	
Salem, Ore. 581-4720						K				K	I	I	I	I	K	
Scappoose, Ore. 543-7350						K				K	I	I	I	I	K	
Vancouver, Ore. 695-9600						K				K	I	I	I	I	K	
Private Lines (PL)																
Nat. Weather Service (NWS)						K				K	K	K	K	K	K	4
Fixed Base Operators (FBO)						K				K	I	I	I	I	K	5
SS-1 Trunks (SS-1)																
Seattle, Wa. ARTCC					K	K	K	K	K	K	K	K	K	K	K	6
Portland ATC Facilities						K	K	K	K	K	K	K	K	K	K	6
Intercom (IC)	K	K	K	K	K	K	K	K	K	K	K	K	K	K	K	

Remarks:
1. Facility administrative telephone number, not programmed to the ACD.
2. Facility pilot briefing telephone number, programmed through the ACD.
3. Remote area pilot briefing telephone number, programmed through the ACD.
4. Auto-ringdown line used for inbound/outbound calls between NWS and Portland FSS.
5. Auto-ringdown line used for inbound calls from FBO to Portland FSS only.
6. Selective signalling trunk requiring two-digit dialing to the called party.

I = Calls routed by the ACD to the IN key at PF positions.
K = Discrete key termination.

the IN key on his console. If all PF positions are busy, an additional 16 calls can be routed by the ACD to PCQ. In the Portland ACD, there is sufficient PCQ capacity to hold all trunks in queue.

The Portland FSS has four PF positions which are operationally identified as PF-1, PF-2, PF-3, and PF-4. The ACD, when scanning for a nonbusy position, uses a rotary order of PF-1, PF-2, PF-3, PF-4, PF-1, etc. Each incoming call to the ACD is routed by the ACD to the next nonbusy PF position that follows the PF position last served. If all positions are busy, the ACD will route the call to PCQ and hold the call in queue until a position becomes nonbusy or the calling party disconnects.

The ACD will cause a recorded delay announcement to be played back to the calling party after the call has been placed in PCQ. Calls already in PCQ will be released by the ACD on a first-in-first-out basis as PF positions become available. A detailed description of the ACD is contained in appendix A.

INTERPHONE SERVICE.

Two interphone (IP) trunks can be accessed from each of the following positions: AC, PF, FD, IF, EF, and teletype (TT).

Trunk 4GP9231 interfaces the Portland FSS with the Seattle (ZSE) Air Route Traffic Control Center (ARTCC). Attendant control sectors at the ARTCC are The Dalles, Hoquiam, Toledo, North Bend, Portland, and Eugene. A discrete two-digit dial code is assigned to each control sector, thus providing Portland FSS specialists selective sector access. Dial tone and ringback signal is not provided for outbound calls on the trunk. Incoming calls from Seattle ARTCC are identified by a ringdown-until-answered signal from a ringer device located at IF console No. 1. Dial code 50 is used by Seattle ARTCC controllers to access the Portland FSS. This code does not provide selective position access within the FSS.

Trunk 62GP700 interfaces Portland FSS with five air traffic control (ATC) facilities located within the Portland, Oregon, metropolitan area. Attendant ATC facilities are Troutdale Tower, Hillsboro Tower, Portland Tower, Portland National Weather Service, and Portland Radar Approach Control. This trunk terminates at three attendant position in the Portland Radar Approach Control facility and at one attendant position in each of the other facilities. A discrete two-digit dial code is assigned to each attendant facility and for each of the three attendant positions in the Portland Radar Approach Control facility, thus providing Portland FSS specialists selective facility/position access. Dial code 24 is used by controllers at the metropolitan area facilities to access Portland FSS. This code does not provide these controllers selective position access within the Portland FSS. Dial tone and ringback signal is not provided for calls outbound from Portland FSS. Incoming calls are identified by a ringdown-until-answered signal from a ringer device located at IF console No. 1.

Control logic for the interphone service is mounted in the control racks of the telephone equipment room. All logic, amplifiers , decoders, encoders , and interfaces are standard WESCOM 400 series cards.

INTERCOM SERVICE.

Interposition coordination (IC) within the Portland FSS can be effected through use of a model KR-16 McIntosh Tel Key System. It is described in appendix D. This system provides position interconnection service to 2 administrative, 2 maintenance, and 11 operational telephone consoles. Extension of this service to the conference room and to the Deputy Chief's office will be effected in the near future.

Intercom access requires the depression of the COM key on the GTE telephone console. A calling party must dial a one- or two-digit discrete code applicable to the desired position interconnection. Dial tone is not provided. One burst of ringback signal is heard by the calling party, and one burst of ringdown signal is heard by the called party. In addition, the called party's COM key status backlight will be illuminated in FLASH mode and the remaining complement of console COM keys (13 keys) will be illuminated in STEADY mode. The called party's COM key status backlight will revert to STEADY mode when that key is depressed.

Once a two-party intercom connection has been established, additional discrete two-party connections cannot be established. However, any specialist having access to any COM key can join the original two-party connection merely by depression of the COM key on his telephone console. Thus, a multiparty conference of up to 15 specialists (eventually 17 specialists) can be effected. This conference capability was evaluated and was judged to have produced no degrading effect on the intercom readability factor.

In the typical Portland FSS operational mode, it was noted that the operational specialists use the intercom system very infrequently. System use to/from the administrative and maintenance positions must also be categorized as very infrequent. Actual (tabulated) system usage statistics are not maintained.

RADIO SYSTEM.

Telephone consoles installed at the PF, IF, and EF positions are equipped with a radio speaker and a Radio Transfer (RAD) key. When this key is in the depressed position, the WESCOM system will:

1. Interface the position with the FAA radio system, thus providing the specialist with access to those VHF frequencies appropriate to his position.

2. Inhibit outbound telephone calls from any console having a depressed RAD key.

3. Continue to route only IP and IC calls to PF consoles having a depressed RAD key.

4. Continue to route all types of telephone calls to the IF and EF positions for which these positions are eligible to receive.

Incoming radio calls will be directly routed by the FAA radio system to the radio speaker or to the specialists headset or handset as appropriate. The speaker is equipped with a combination ON-OFF volume control switch and an ON-OFF status indicator.

MONITOR SUBSYSTEM.

The Monitor Subsystem display is identified as the Automatic Call Distributor Status Panel. This panel is located at the AC desk and provides the AC with the following types of information:

1. Trunk status,

2. Preflight position status,

3. System power status, and

4. Data count registers for:

   a. Each PF position,
   b. Total calls,
   c. Delayed calls,
   d. Abandoned calls,
   e. All trunks busy.

Technical information pertinent to the ACD Status Panel is contained in the TECHNICAL SYSTEM DESCRIPTION.

POWER SUBSYSTEM.

A description of the Power Subsystem is contained in the TECHNICAL SYSTEM DECRIPTION.

ATTENDANT POSITION EQUIPMENT.

Position equipments such as telephone consoles, desk sets, wall sets, and jack modules are furnished by GTE. Two types of consoles are in service in the Portland FSS Operations Room. Each PF and IF position is equipped with a 12-key console (figures 1 and 2). The following positions are equipped with 30-key consoles (figure 3): AC, FD, and EF. Administrative positions are equipped with 10-key desk consoles. Maintenance and teletype positions are equipped with five-key desks sets. Figure 4 illustrates an IF console.

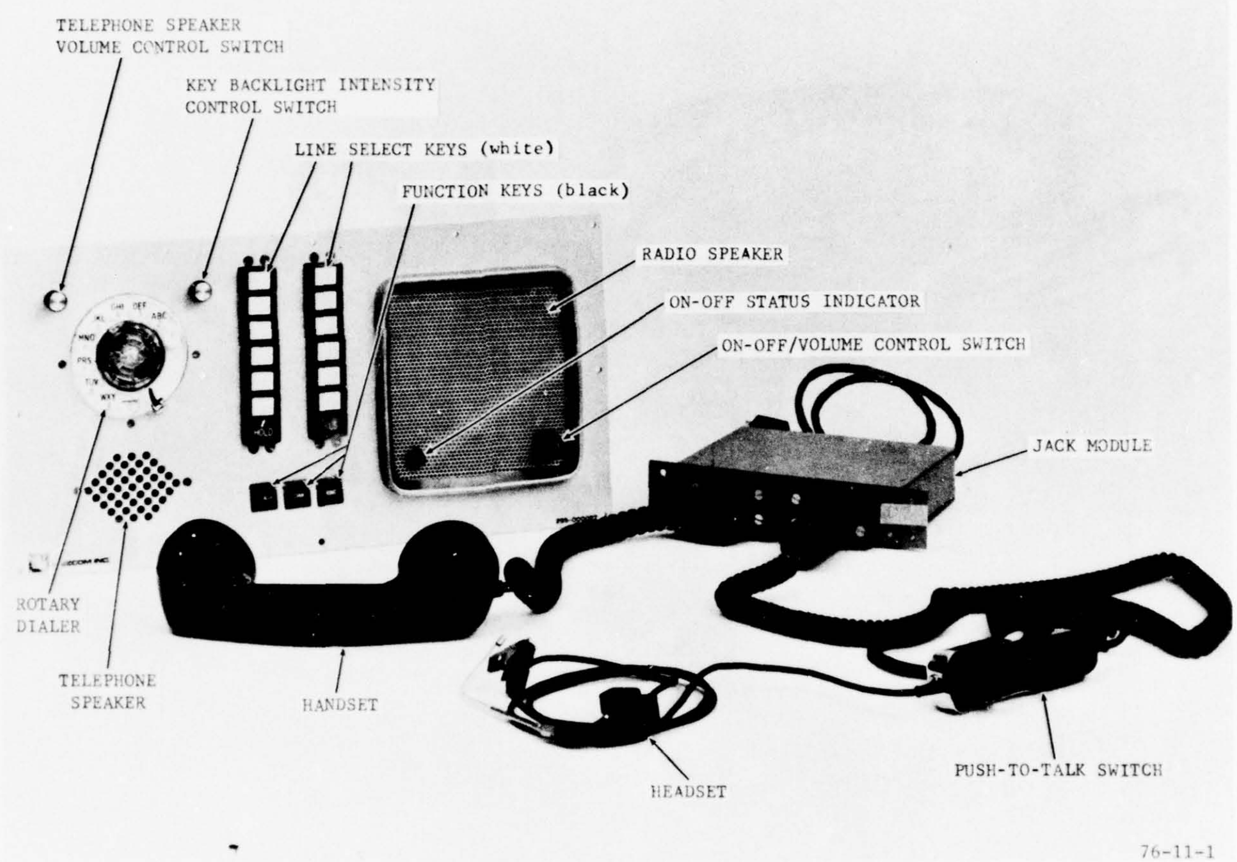

FIGURE 1. 12-KEY POSITION CONSOLE, JACK MODULE, HANDSET AND HEADSET

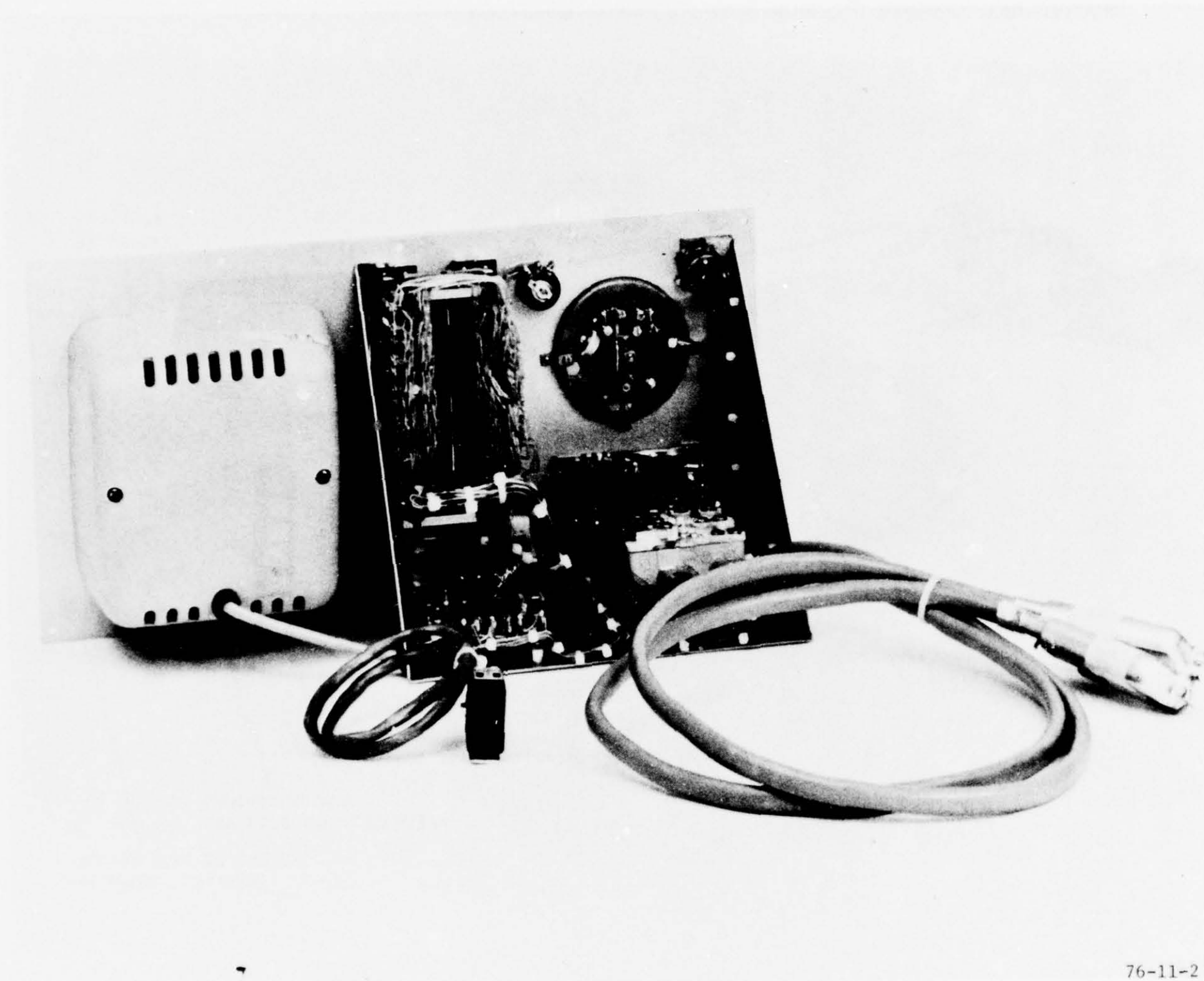

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FIGURE 2. 12-KEY POSITION CONSOLE (REAR VIEW)

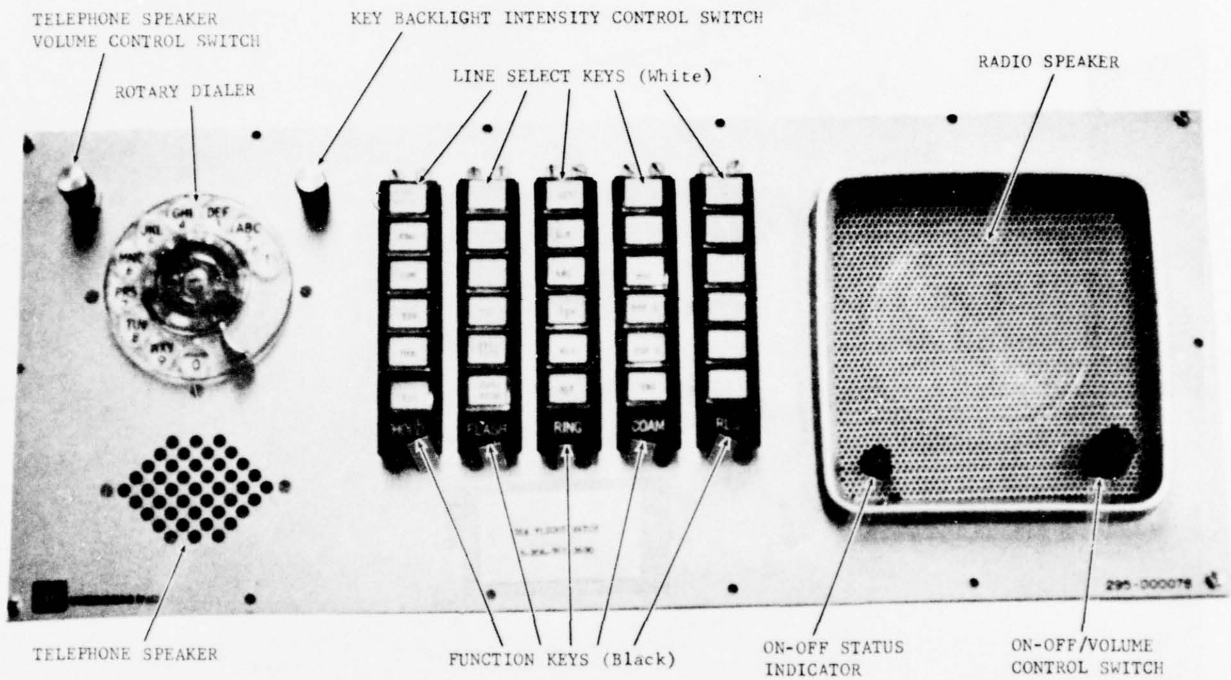

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FIGURE 3. 30-KEY POSITION CONSOLE

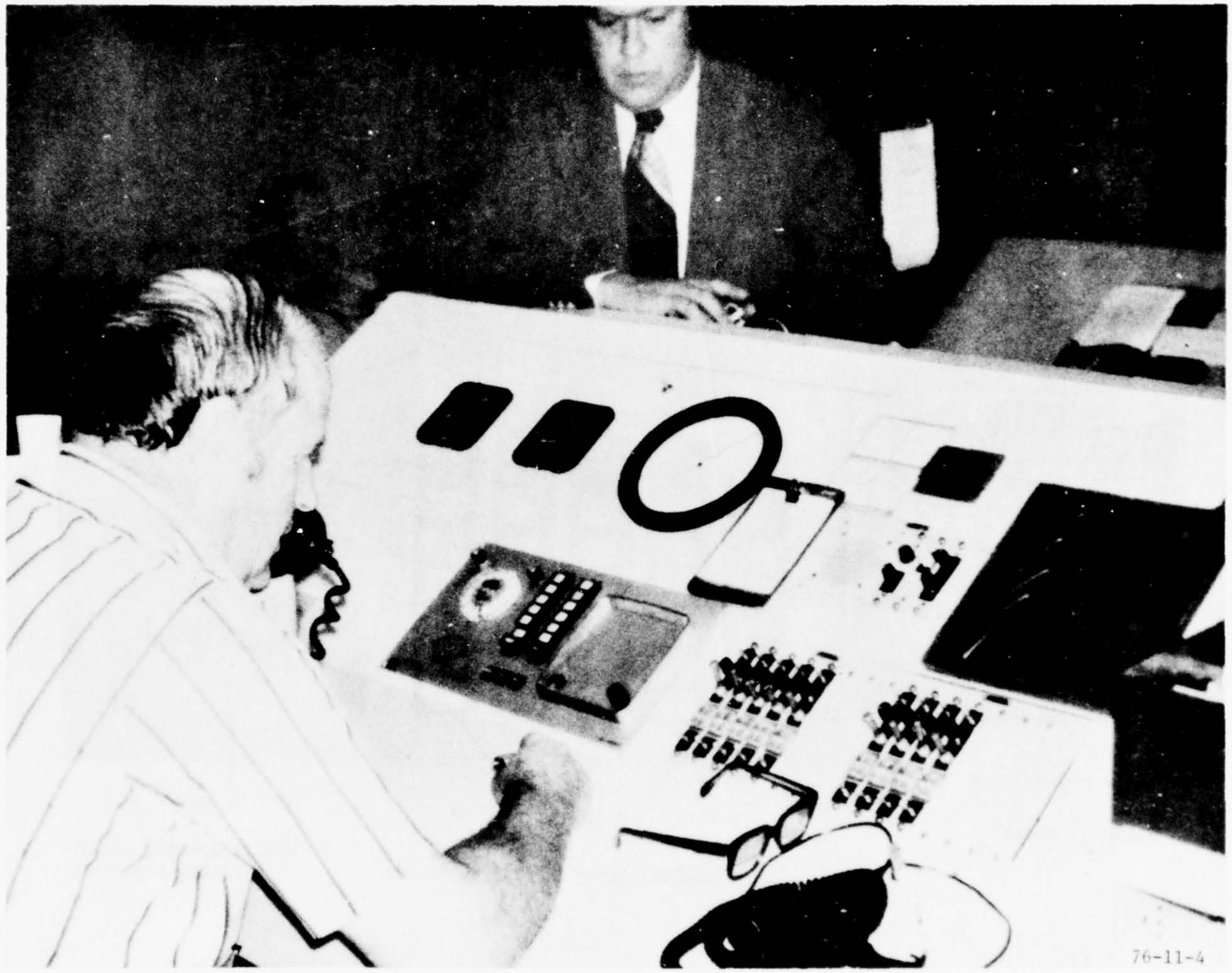


FIGURE 4. 12-KEY WESCOM CONSOLE INSTALLED AT INFLIGHT POSITION NO. 2

The following function keys are incorporated in all 12- and 30-key consoles:

1. RELEASE Key - A nonlocking key used to release a previously selected line key at the termination of a call.

2. FLASH Key - A nonlocking key used to disconnect from a ground-based circuit.

3. HOLD Key - A nonlocking key used to place a call in hold status while answering another call.

4. RING Key - A nonlocking key used for manual ringdown circuits. This key is not programmed for use with the Portland WESCOM system.

5. COAM Key - A nonlocking key used for facility door control. This key is not programmed for use with the Portland WESCOM system.

Three additional function keys are a part of each PF console:

1. IN Key - A special purpose key which, when depressed, conditions the CCS to route all incoming calls on trunks dedicated to the PF activity to the ACD which will then route these calls to those PF positions having a depressed IN key.

2. A/G - Air/Ground Transfer Key. A nonlocking key used to transfer a CO, FX, or PL call from an inservice PF position to an IF position.

3. NWS Key - National Weather Service Key. A nonlocking key used to transfer a CO, FX, or PL call from an inservice PF position to the NWS office located in Portland, Oregon.

One additional function key is a component of each IF console:

1. PF Key - A special purpose key used by the IF specialist to receive a CO, FX, or PL call transferred to his position from a PF position.

Table 1 outlines the trunk terminations applicable to each administrative, maintenance, and operational position in the Portland FSS. Table 2 outlines a schedule of function key availability at each position. Figure 5 is an annotated line drawing of a 12-key position console. Figure 6 is an illustration of the floor plan of the Portland FSS Operations Room.

Line keys are mechanically interlocking keys, and are equipped with a status backlight to give either steady or flashing visual indication of line status. A rotary control switch can be used to adjust the backlight intensity of all line and function keys. Each position is equipped with a jack module and either a handset or headset. Handsets and headsets have a push-to-talk (PTT) switch.

TABLE 2. FUNCTION KEY SCHEDULE - PORTLAND FSS

Positions of Operation

Function Key	FC	SEC	AFS 1	AFS 2	TT	AC	IF 1	IF 2	IF 3	EF	PF 1	PF 2	PF 3	PF 4	FD	Remarks
HOLD KEY	X,C	X,C	X,C	X,C	X,C	X	X	X	X	X	X	X	X	X	X	1,2
RLS KEY						X	X	X	X	X	X	X	X	X	X	1
FLASH KEY						X	X	X	X	X	X	X	X	X	X	1,3
A/G Transfer Key											X	X	X	X	X	1,4,7
PF Key						4	3	3	3							5,7
RAD (Radio) Access Key							X	X	X	X	X	X	X	X		8
NWS Transfer Key											X	X	X	X	X	1,6

Remarks:
1. Nonlocking keys are indicated by "X", or a single digit.
2. Desk sets locations are indicated by "C".
3. Special purpose key used to disconnect from ground-based circuits.
4. Call will be routed by the ACD to IF queue if all IF positions are busy.
5. A digit is used to indicate the number of programmed PF keys in the position's telephone console.
6. Call will be routed by the ACD to NWS queue if the National Weather Service (WX) Line is busy.
7. The A/G transfer keys and PF keys are associative keys.
8. Special purpose key used to access VHF radio.

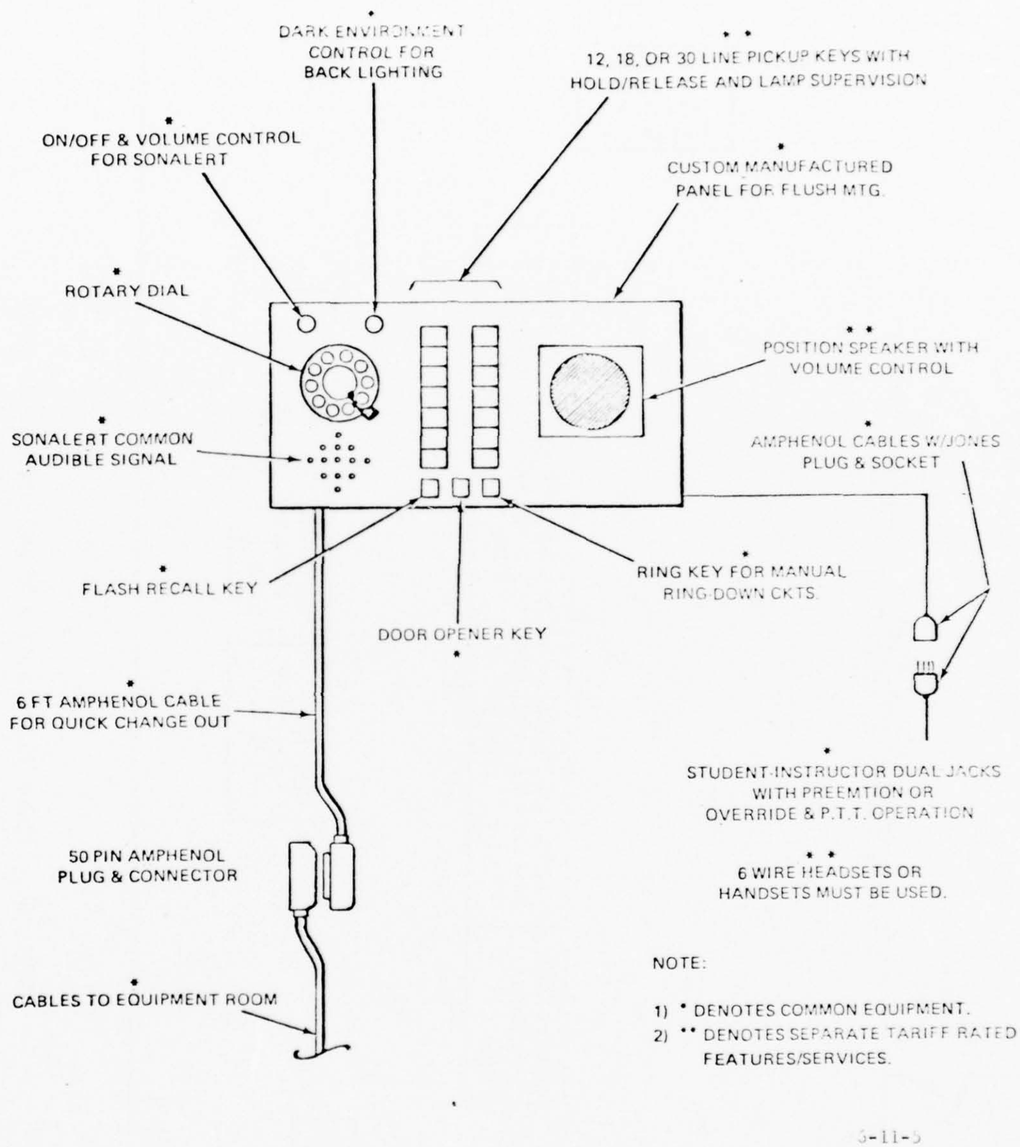


FIGURE 5. ANNOTATED LINE DRAWING OF A 12-KEY WESCOM POSITION CONSOLE

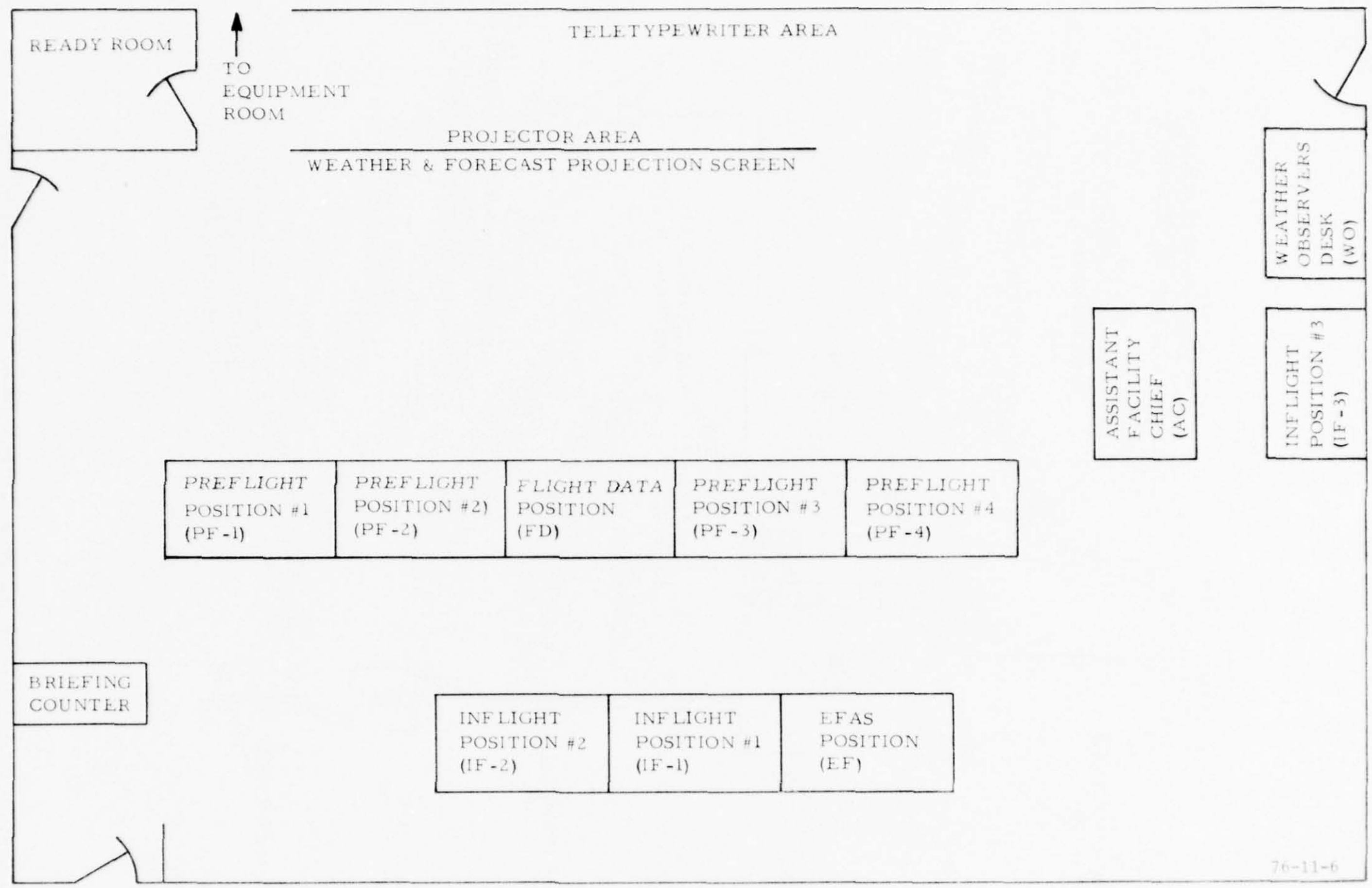


FIGURE 6. FLOOR PLAN, PORTLAND FSS OPERATIONS ROOM

All telephone consoles in the Portland FSS Operations Room have a built-in speaker to receive an incoming telephone call. The speaker volume control is a rotary switch which has a low limit, to prevent the speaker output from dropping below audibility.

The attendant administrative positions are equipped with 10-line desk consoles. Each position can access one CO trunk, two FTS trunks, and intercom. Console line keys are backlighted and are interlocking keys which release upon the subsequent depression of another line key. Line-in-use is indicated by a STEADY backlight, or if the line has been placed in HOLD status, the status backlight will change to FLASH mode. Line disconnect is effected by placing the handset on the console's cradle, or by depressing another line key. Each administrative console has a HOLD function key. This key can be used to place CO and FTS lines on HOLD status, but cannot be used to place an intercom call on HOLD status.

Five-line desk sets are in use at the TT and AFS attendant positions. Lines terminated at the TT position are one CO line, one SS-1 line, and intercom. Lines terminated at the AFS-1 attendant position are one CO line, one FTS line, and intercom. Intercom only is terminated at the AFS-2 attendant position. The usage of these sets is identical to the usage described for the administrative desk consoles.

Inbound/outbound CO and FTS calls to/from the desk consoles and desk sets are processed by the Common Control Subsystem (CCS) of the WESCOM system. Intercom calls are processed by a model KR-16 McIntosh Tel Key system which interfaces with the CCS.

Each PF console has two Call Transfer (CT) keys which , when depressed , allow the specialist to transfer an ongoing CO, FX, or PL call to either the Portland office of NWS, or to a local IF position. CT keys are nonlocking keys. Momentary depression of a CT key will cause the system to transfer the call-in-progress from the PF position to the selected transfer party , and in so doing cause an auto-ringdown signal to ring at the transfer party's telephone console. Subsequently, the ACD will recognize the affected PF position to be inservice, but nonbusy, and to be recognized during the next scan of the PF positions by the ACD.

CO, FX, or PL calls transferred from PF to NWS can be answered at only one NWS telephone position. Similar calls transferred from PF to local IF positions will be transferred to the first nonbusy PF key at the first nonbusy IF position telephone console. Each IF telephone console has three PF keys.

If a busy indication is returned from NWS or from a local IF position, the ACD will cause a Call Transfer Queue (CTQ) to be formed. Calls in CTQ will be released by the ACD on a first-in-first-out basis as transfer lines become available, but will be consistent with a call's tag, either Air/Ground (A/G) or NWS.

The HOLD function at a PF console is applicable only to a call-in-progress routed by the ACD to that console's IN key. The ACD, by system design and

specification, will not simultaneously route a multiple number of, or a combination of CO, FX, and PL incoming calls to the IN key. However, the CCS will route SS-1 and intercom calls to a PF console as the ACD is routing CO, FX, and PL calls to the same console. Calls routed by the CCS will go to the appropriate discrete key and not to the IN key. This is another reason for restricting the HOLD function at PF consoles to the IN key.

PF specialists are alerted to an incoming CO, FX, or PL call by one burst of the Call Alert signal and the simultaneous display of a flashing status back-light under the IN key. PF position status, busy or not busy, is discretely indicated on the ACD Status Panel located at the AC position. Line disconnect may be accomplished by the calling party going on-hook or by depression of the RLS key by the PF specialist. Either action will cause the ACD to change that position's status indicator on the ACD Status Panel to the FLASH mode. STEADY mode is displayed when the PF specialist has an ongoing CO, FX, or PL call.

TECHNICAL SYSTEM DESCRIPTION

GENERAL.

A detailed description of the ACD is contained in appendix A. Figure 7, a simplified block diagram of the system, indicates the capacity of the Portland WESCOM system to be 16 incoming trunks. The hard-wired logic of the ACD is used to connect the trunks to the four PF positions as they become available to take calls. Calls which cannot be immediately answered are held in queue by the Incoming-Call Queue Control and CCS. When incoming calls are delayed due to busy PF positions, a delayed answer recording is immediately played to the calling party. The recorded message is repeated after 36 seconds if the call has not been answered. These trunks may be transferred from their PF connection to the IF positions or to NWS using the Transfer Select Control by the CCS. If the transfer cannot be made immediately to the NWS, or to IF positions at the Portland FSS, a queue is started for the transfers; however, no recorded delay message is played during the delay in transfer.

The electronics and telephone system interfaces were installed in an equipment room of the FSS. WESCOM system electronics are mounted in the racks as shown in figure 8, with the exception of the ACD Status Panel electronics at the Assistant Chief position, and a rack containing line amplifiers of WESCOM 400 series. Thirty-two of the 33 ACD cards are mounted in the first three shelves of bay No. 2 (foreground bay of figure 8), while the 33rd card, Dial and Busy Tone Generator is mounted in shelf No. 9. Between shelves No. 6 and No. 7 is the delayed message recorder. At the base of bay No. 2 are the three power supplies for +5, -15, and +15 volts, which are used exclusively by the system. While in the bottom of bay No. 1 is the -24 volt (V) supply used by the ACD and the CCS. Photographs of the principal card types are shown in figures 9 through 13. Card arrangement and identification is shown in figure 14.

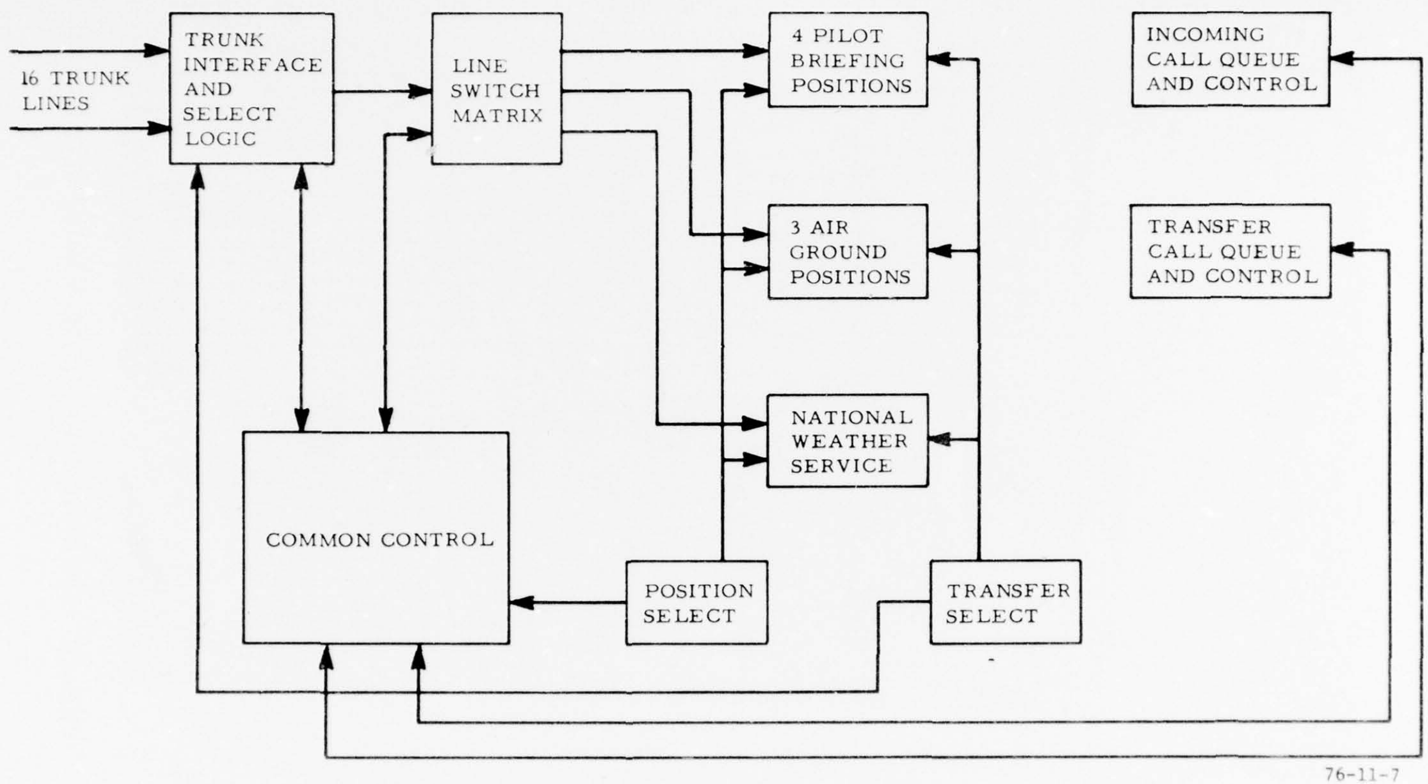


FIGURE 7. BLOCK DIAGRAM GTE/WESCOM KEY/ACD COMMUNICATION SYSTEM

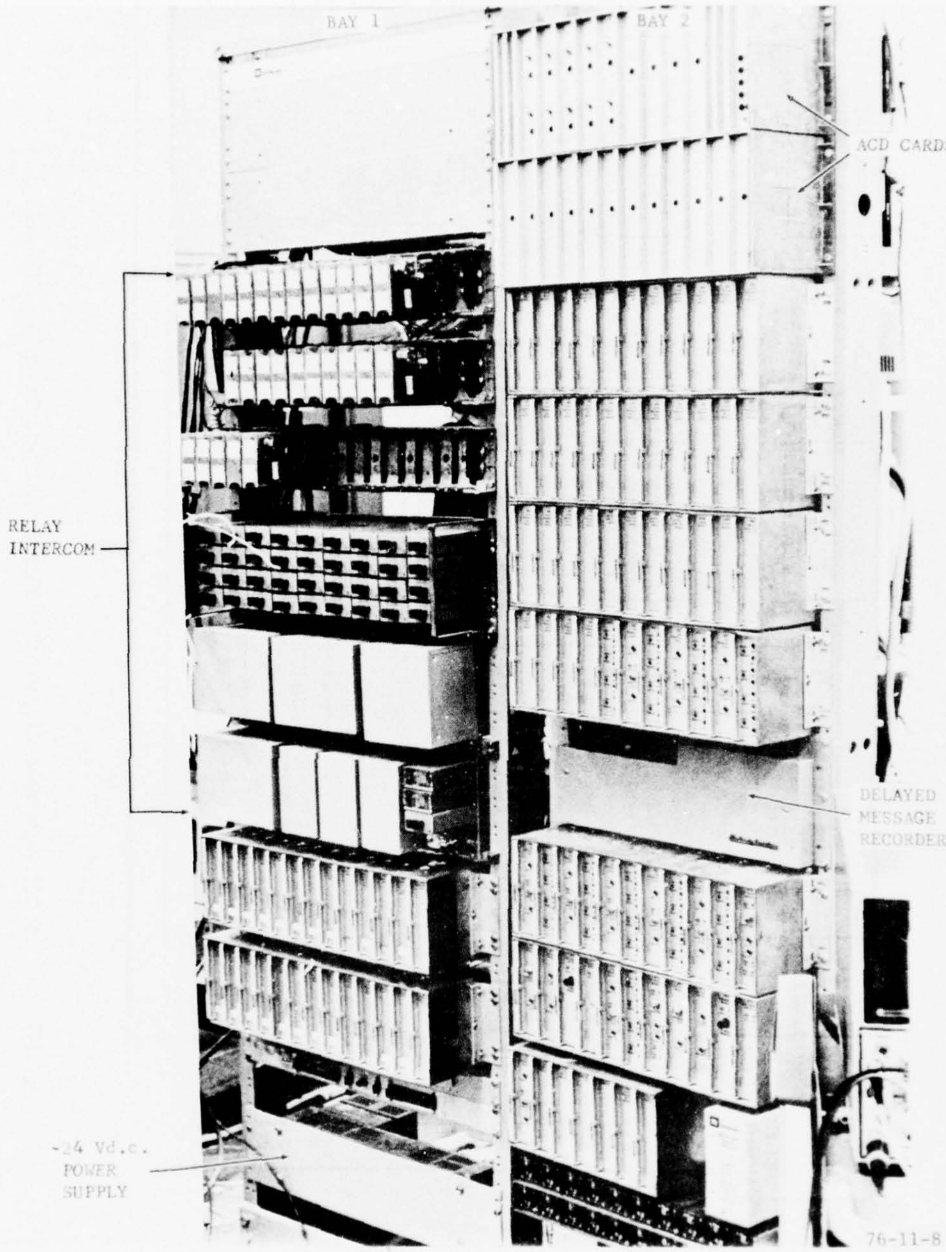


FIGURE 8. AUTOMATIC CALL DISTRIBUTOR IN RELAY RACKS WITH RELAY INTERCOM

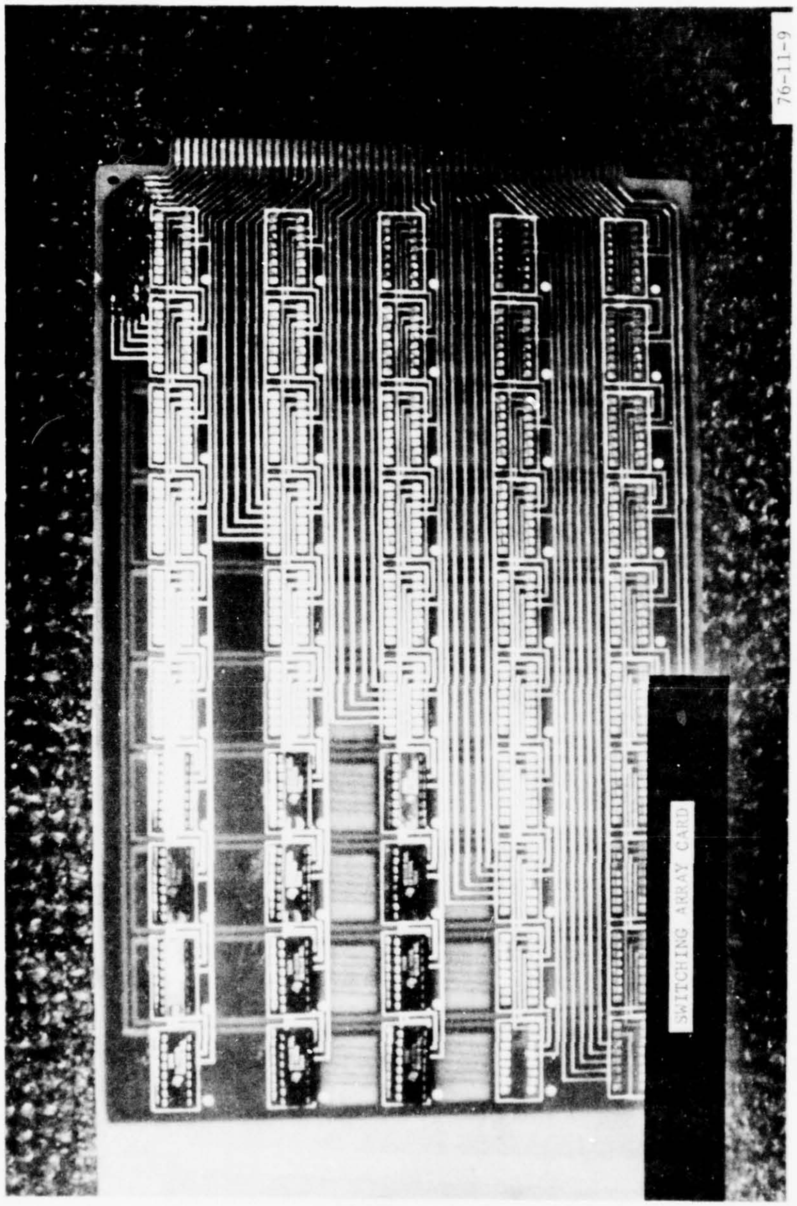


FIGURE 9. SWITCHING ARRAY CARD

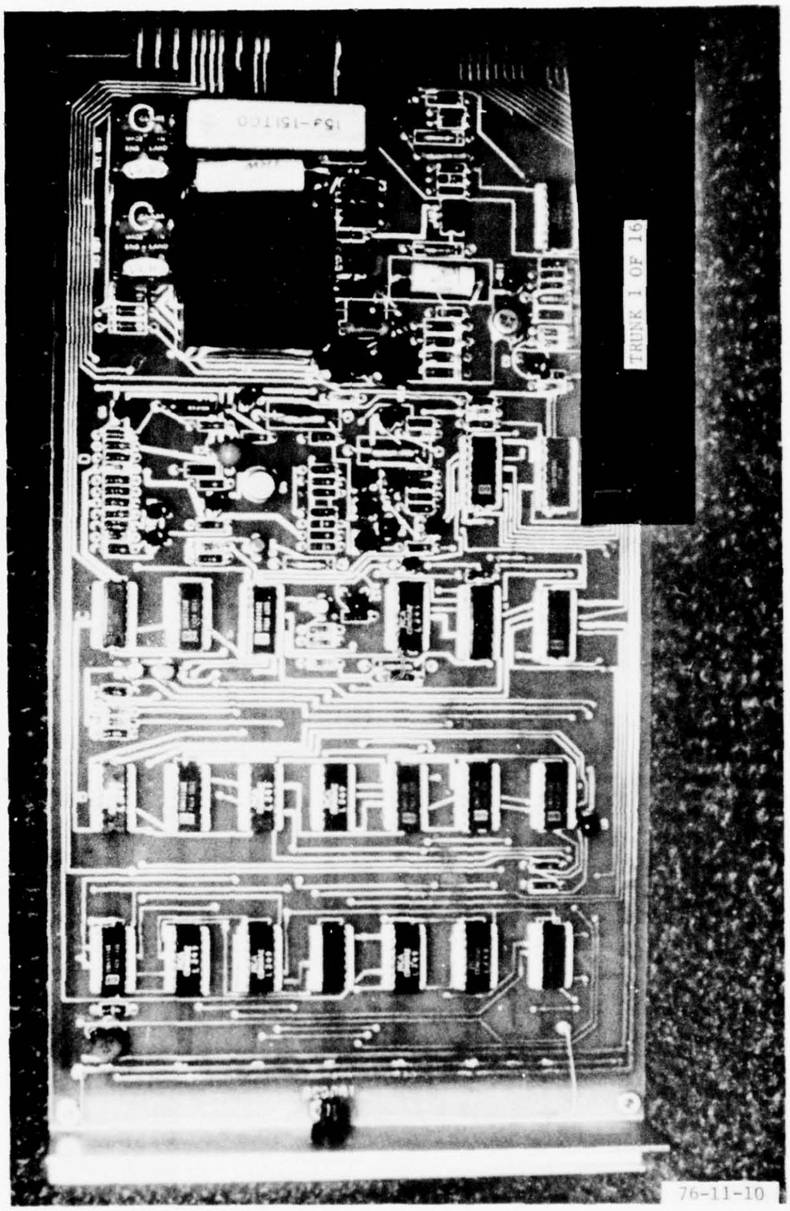


FIGURE 10. TRUNK CARD

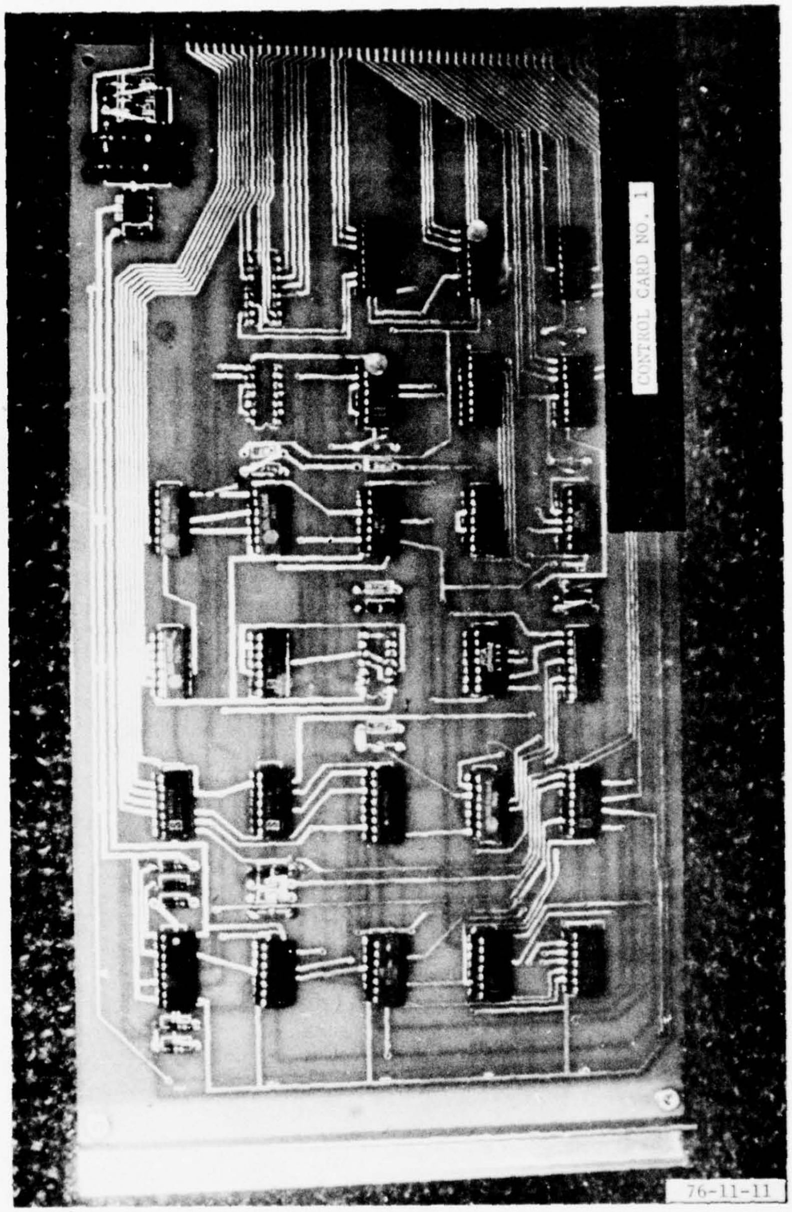


FIGURE 11. CONTROL CARD NO. 1

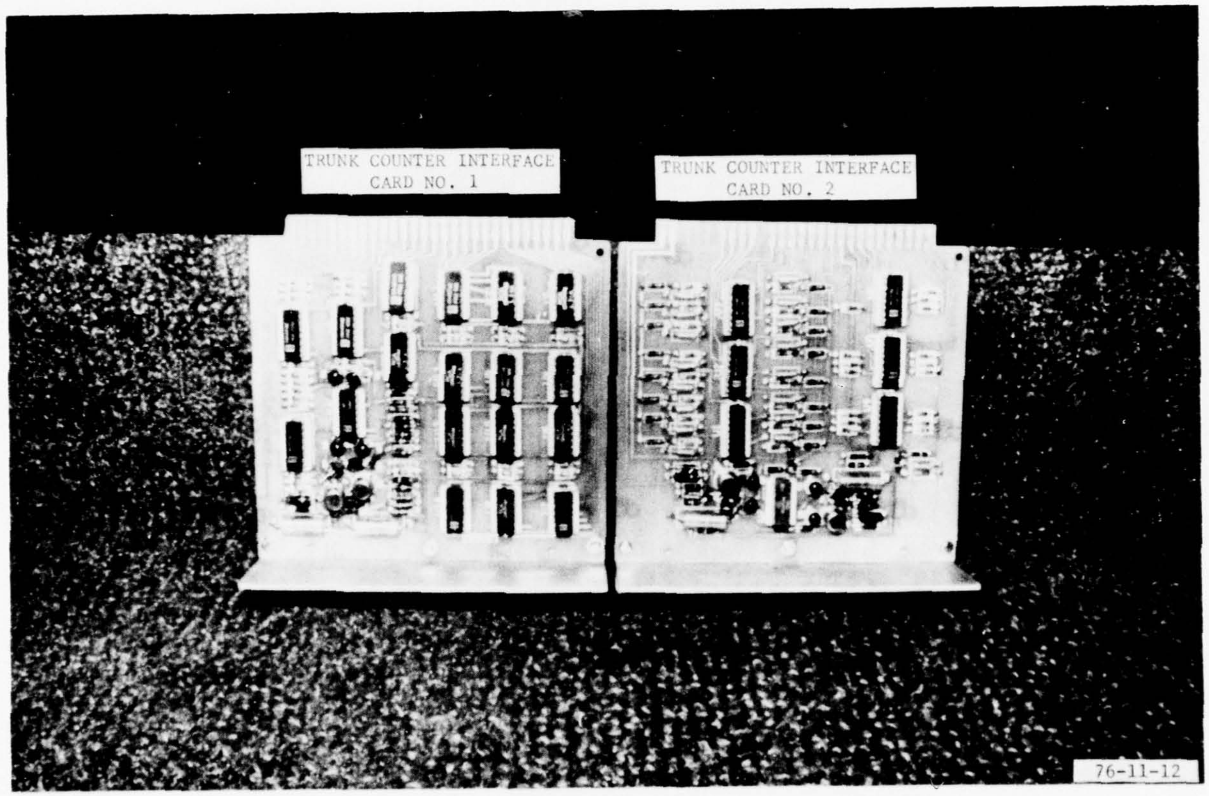


FIGURE 12. TRUNK COUNTER INTERFACE CARDS NOS. 1 AND 2

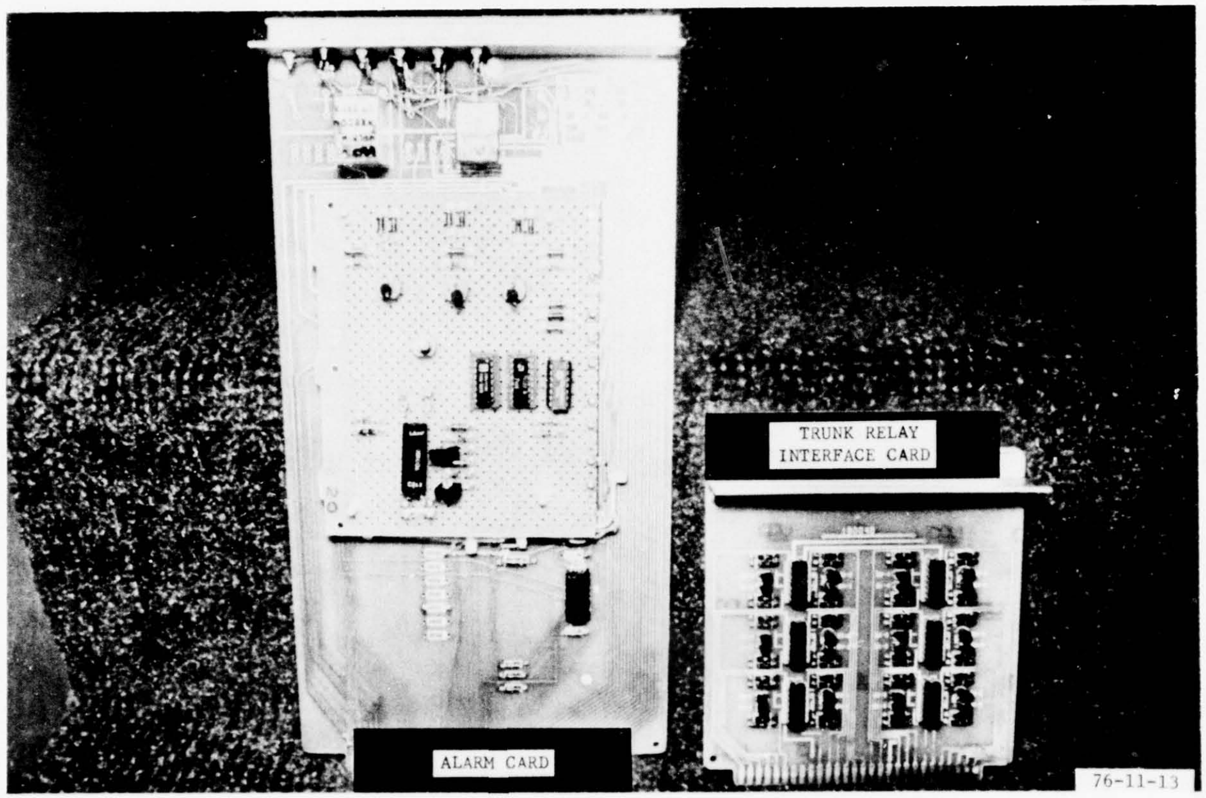


FIGURE 13. ALARM CARD AND TRUNK RELAY INTERFACE CARD

FIGURE 14. SHELVES NO. 1 AND NO. 2 OF AUTOMATIC CALL DISTRIBUTOR MODULES

POWER SUPPLIES.

Power supplies of the WESCOM system are as follows:

1. -24 V d.c. Power Supply. This supply is manufactured by North Electric Company, Incorporated and is rated at 10 amperes. It operates on 115 V a.c., and is adjusted to deliver 24 V with a capacitive pi filter output.

2. +5, ±15 V d.c. Power Supplies. These supplies are produced by Power Mate Corporation and are of their type UNI-30 models. Type UNI supplies may be field-adjusted for any desired voltage from 0 to 30 V d.c.. The units are also equipped with overvoltage protection, which has been set at 2 V d.c. above the required voltage.

SYSTEM PARAMETERS.

System parameters of the WESCOM system are as follows:

1. Audio Signal Insertion Loss: 2.0 to 2.3 dB at 0 dBm, 1 kHz.

2. Audio Input Limit: +3 dBm, no lower limit.

3. Suggested Input Level: 0 dBm at 1 kHz.

4. Isolation: -55 dBm to -65 dBm.

5. Amplification Distortion: No amplification, except for recorder output.

6. Power Requirement: 115 V a.c., 60-Hz input, for power supplies of +5 V d.c., and ±15 V d.c., -24 V d.c.

SYSTEM INTERFACES.

Each trunk is interfaced with a circuit for either loop or ground start calling mode. The loop start mode uses a ring detector which closes the line loop and enables the voltage detector as a result of the CO ringing voltage. Certain CO transmission equipments are designed to apply constant battery voltage to the trunk. This design makes electrical detection of calling hang-up following trunk connection impossible. In the Portland area, CO's having this design include Aurora, Newburg, McMinnville, Scappoose, and Hillsboro, which have trunks terminating at the PF, AC, EF, and FD positions. An especially difficult condition occurs when these trunks are transferred to NWS, which also has battery feed. Under this condition, both trunks must be released in order to drop the trunks.

All trunks are terminated in amplifiers in the equipment room before connection to the CCS. The amplifier used is the WESCOM No. 401 Line Amplifier, which provides an adjustable output of up to +3 dBm. The output adjusted for the system is 0 dBm. The level was raised from -4 dBm after the level was found to be too low at the operating positions, which was approximately -6.3 dBm at the headset jack.

The insertion loss in the system through to the headset jack is approximately -2.3 dBm. There are no line amplifiers in the system, and the only distortion of the system is found in the isolation transformers. Further, there are no audio amplitude adjustments in the system. Isolation in the integrated circuit switching array is a minimum of -60 dB, while in the complete system this is expected to be not less than -55 dB. The latter value is a function of the particular installation. For comparison, also connected to the positions are the intercom lines. These lines may be 2 to 3 dB above the levels on the telephone lines.

Audio recordings are made for all of the operational FSS positions with the exception of the AC and FD positions. No beep tones are put on the lines to make the calling party aware of the recording. Due to the nature of the FSS service, this has been declared legal. The audio signal is amplified in the system, if in the telephone mode, fed to an SS-1 line amplifier, and then to the FAA nine-track tape recorder. The receive and transmit audio bypasses the system amplifier, and is fed to the standard FAA amplifier before going to the recorder. The output of the 727 amplifier (type SS-1) is adjusted to approximately 0 dBm.

DELAY MESSAGE RECORDER.

In the event that all operating PF positions are busy, the delay message recorder is started to inform the callers that there will be a delay before a specialist will be available. The recorder used is an Electronic Secretary, by Automatic Electric, with an endless loop tape. Front panel controls and inputs of the recorder are as follows:

	Controls	Positions
1.	Control Switch	Automatic, Monitor, and Record
2.	Momentary Contact Switches	Start and Erase
3.	Power Switch	On and Off
4.	Input	Microphone
5.	Monitor Lamp	Indicates Tape Playing

The recorder tape play may be initiated manually or automatically to the point where the tape motor control switch is lifted from the slot in the center of the tape by its forward movement. The duration of the tape motion, as indicated by the monitor lamp, is approximately 14 seconds. The time to traverse the tape slot is about 1 second. To record, the microphone must be plugged in and the control switch turned to the appropriate position. The microphone is used as a monitor speaker when the control switch is set to monitor and the tape started.

The output of the recorder is branched to 16 separate outputs in the recorder interface and connected to the trunk cards for connection to the particular trunk to receive the delay message.

EXPANSION CAPABILITY.

The ACD recognizes up to four PF positions; one CO line; one inbound PL line; and nine FX lines. This switching capability, at Portland FSS, could be increased to a maximum of 16 lines. In a fully expanded system up to 128 trunks could be switched by the system and distributed to as many as 30 PF positions.

CALL PREEMPTION FROM AC TELEPHONE CONSOLE.

The AC telephone console has four keys programmed for call preemption. Key identifiers are: PF-1, PF-2, PF-3, and PF-4. These keys relate to similar numbered PF positions and serve an entirely different function than those keys identified as "PF" keys on IF telephone consoles. The separate purpose of the numbered PF keys on the AC telephone console is to provide the AC with the capability to monitor an on-going CO, FX, or PL call at a specific PF position.

AUTOMATIC CALL DISTRIBUTOR STATUS PANEL.

The ACD Status Panel (figure 15) is slope mounted on the AC desk in close proximity to the NAVAID monitor panel, transmitter/receiver select panel, and adjacent to the AC telephone console. The system collects and relays eight types of system data to the ACD status panel:

1. Incoming Trunk Status Indicators: Sixteen light (mode) indicators includes one indicator assigned to each incoming trunk. Currently, nine FX trunks, two PL trunks, two FTS trunks, and two CO trunks are being monitored. Light modes are as follows:

    a. FLASH mode - indicates a call is waiting to be answered.
    b. STEADY mode - indicates a call is being handled.
    c. OFF mode - indicates the trunk is idle.

2. Preflight Position Status Indicators: Six light (mode) indicators include one indicator assigned to each PF position. Currently, four PF positions are being monitored. Light modes are as follows:

    a. FLASH mode - indicates that the position is not busy.
    b. STEADY mode - indicates that the position is busy.
    c. OFF mode - indicates that the position is not staffed or that the specialist is using intercom, interphone, or radio.

3. Preflight Call Register: A discrete register is assigned to each PF position. The displayed number represents the current cumulative total of all calls routed to the identified position by the ACD. The register cannot differentiate between CO, FX, or PL calls. Cumulative call duration time is not available and reset to zero is not possible.

4. All Trunks Busy Register: A discrete register which displays a current cumulative number of times the 11 PF trunks are simultaneously busy. Reset to zero is not possible, nor is cumulative call duration time available.

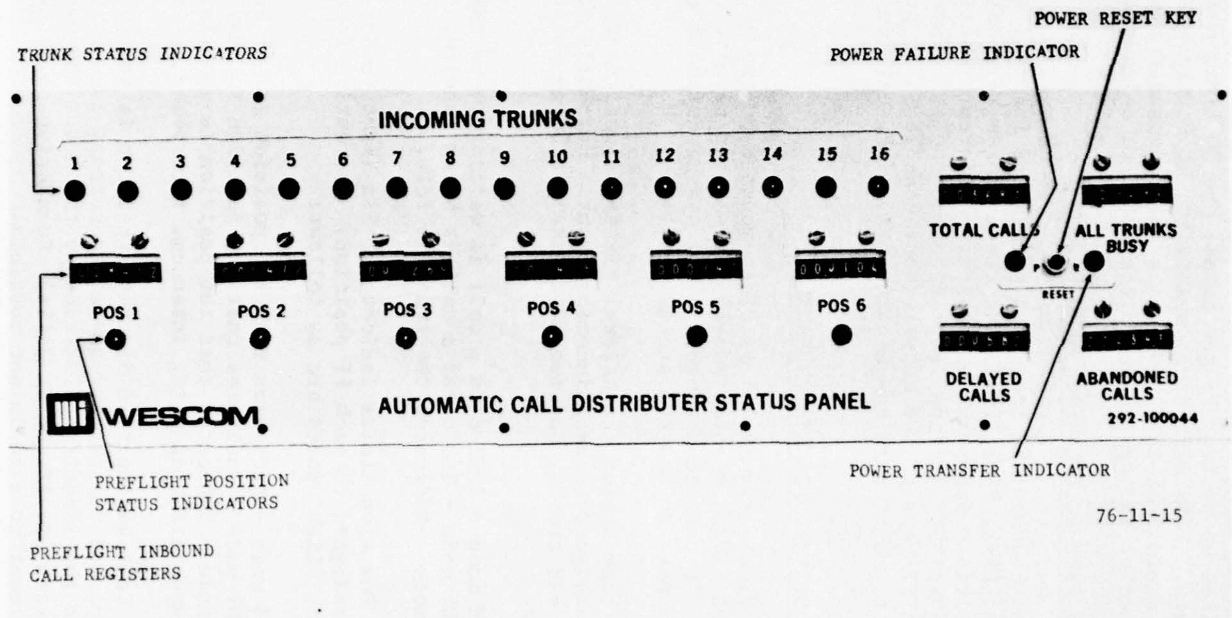


FIGURE 15. AUTOMATIC CALL DISTRIBUTOR STATUS PANEL

5. Delayed Calls Register: A discrete register which displays the current cumulative number of incoming calls for which the calling party was in standby status for more than 30 seconds awaiting a connection to a PF position. Reset to zero is not possible.

6. Abandoned Calls Register: A discrete register which displays the current cumulative number of incoming calls, which were abandoned by the calling party prior to being connected to a PF position. Reset to zero is not possible.

7. Total Calls Register: A discrete register which displays the current cumulative number of incoming calls routed by the ACD to PF positions. This register cannot distinguish between CO, FX, and PL calls. Reset to zero is not possible.

8. Power Failure Indicator: This indicator has two visual warning lamps and a depressible reset key. It is the only warning device in the entire system. The lamps are identified as "P" and "R" lamps, each lamp having two modes of illumination.

a. P Lamp - OFF mode indicates that power is ON.
ON mode indicates that power is OFF or has been OFF.

b. R Lamp - OFF mode indicates that power transfer is OK.
ON mode indicates a power transfer failure.

EVALUATION PLAN

PURPOSE.

The purpose of this activity was to determine, through test and evaluation of the candidate WESCOM system in service at the Portland FSS, those operational and technical attributes, including ACD, which should be incorporated into a ground-to-ground voice communication system specification for an automatic call distributor and common switching communication system for those FSS's categorized as high-activity facilities.

METHOD.

Portland FSS is a full-time commissioned facility responsible for the provision of a long list of services to all users of the National Airspace System. This list of services can generally be categorized as PF, IF, FD, and EF types of service. Thus, the FSS mission precludes strict adherence to usual research and development (R&D) system evaluation test practices pertinent to evaluation design, planning, preparation, scheduling, conduct, and data collection. The last three items are most important and applicable to FSS onsite R&D activities.

NAFEC team members, in August 1975, conducted a 5-day onsite operational/technical familiarization study of the Portland FSS. This study was necessary to obtain project planning information relative to (1) FSS environmental conditions, (2) operational characteristics and requirements applicable to each type of operating position, (3) interposition and interfacility coordination requirements, (4) position staffing under varying conditions of workload volume, (5) type and distribution of telephonic services to the several administrative, maintenance, and operational positions, and (6) consultation with FAA and industry representatives relative to WESCOM system design, installation, maintenance, and performance history. As a result of this study, the NAFEC team compiled a baseline for operational/technical evaluation of the WESCOM system. This was documented in a detailed test plan, including scripts and questionnaires to be administered during the evaluation at the Portland FSS.

Four methods of evaluation were utilized to gain data and insight applicable to this WESCOM system:

1. Observation of position operation during an extended period of day and evening shift operations to determine the degree of usefulness and value which unique features of the system contribute.

2. Conduct of script-type testing of the various features of this system to exercise all logic and operational features.

3. Develop a comprehensive operational/technical questionnaire (appendix B) to gain subjective response from facility specialists. This response would subsequently be used by the evaluation team to prepare and conclude statements relative to system utility and acceptance.

4. Analysis of equipment function, facility maintenance, and operational logs.

SYSTEM EVALUATION

SPECIFIC OBJECTIVE.

The Portland FSS is a continuously operational facility; therefore, it was not possible to conduct in-depth specific testing and/or evaluation of system components in order to determine conformance to operational specifications and parametrics. Consequently, it was assumed that this system met those technical and operational requirements necessary to service multiple and simultaneous incoming/outgoing telephone calls via the several types of trunks and lines terminated at this facility. Therefore, the specific objective of this evaluation was to subject this communications system to a series of system operation and functional evaluations conducted in the ongoing operational environment to determine whether or not this particular system should be considered operationally capable of serving the telecommunications requirements of high-activity FSS's having an annual activity in excess of 400,000 service operations.

TEST ENVIRONMENT.

Evaluation of the candidate WESCOM system was accomplished at the Portland FSS situated in Hillsboro, Oregon. This facility is one of approximately 50 FSS's categorized as high-activity facilities.

Scheduled evaluations considered all positions of operation in the Operations Room (figure 6) as well as attendant positions located in the administrative and maintenance areas of this facility. Types of telephone consoles that were evaluated are identified in figures 1 to 4. Other system equipment investigated is identified in figures 8 to 14.

Local and remotely controlled telephone calls, originating at government and nongovernment facilities normally associated with this facility, were input to this system. Ongoing FSS operations prohibited adherence to a firm and precise time schedule for activity conduct and data collection. Accordingly, scripted evaluation activity was initiated only during light-to-moderate periods of FSS activity during the hours of 0800 to 2400 Pacific Standard Time. Nonscripted activities (investigations not requiring participation of FSS specialists) were not materially affected by the ongoing FSS activity, nor was it at any time necessary to abort an FSS operational or NAFEC evaluation activity.

APPROACH.

Operational evaluation of the candidate WESCOM system was accomplished through use of a set of seven activity scripts (table 3). Five special evaluations were accomplished and are also identified in table 3. Applicability of the special evaluations was restricted to PF position No. 1.

The technical evaluation was based on the scripted test results described below, the accumulated data on system performance parameters, performance monitor observation, and failure logs. The areas of evaluation and analysis of the technical data base are as follows: (1) logic performance, (2) reliability, (3) maintainability, (4) trunk interfaces, and (5) expansion potential.

The FSS operational environment mandated the development and subsequent use of dual-purpose scripts. Seven scripts were designed to serve the operational and technical evaluations of this system. Each script identified a number of sequential action items to be accomplished by the test support specialist, and for each action item, one or more questions were detailed in the script for his immediate response. Such questions were designed to obtain data, factual or subjective as applicable, relative to one or more system factors applicable to the in-use script. Table 3 identifies the factors and applicable activity scripts. Script implementation was in the sequential order identified in table 4.

TABLE 3. EVALUATION APPLICABILITY OF OPERATIONAL (FSS) SYSTEM FACTORS

Evaluation Factors	Applicable Activity Script							Special Evaluation				
	1	2	3	4	5	6	7	1	2	3	4	5
Line Access	X	X	X	X	X	X	X	X	X	X	X	X
Dial Tone		X				X			X	X	X	X
Dialer Action	X	X		X	X	X			X	X	X	X
Auto-Ringdown			X									
Ringback Signal	X	X				X			X	X	X	X
Readability	X	X	X	X	X	X	X	X	X	X	X	X
Line Noise	X	X	X	X	X	X	X	X	X	X	X	X
Crosstalk	X	X	X	X	X	X	X	X	X	X	X	X
Line Hold		X				X						
ACD Call Sequence: In							X	X	X	X	X	X
ACD Call Sequence: Out							X	X	X	X	X	X
Delay Announcement							X					X
ACD Primary Call Queue							X					X
Call Transfer							X				X	X
Air/Ground Queue (CTQ)							X					X
NWS Queue (CTQ)							X					
Line Release	X	X	X	X	X	X	X	X	X	X	X	X
Dropped Call	X	X	X	X	X	X	X	X	X	X	X	X
Key Backlight Mode	X	X	X	X	X	X	X	X	X	X	X	X
Responding Sector				X								
Responding Facility					X							
Responding PF Position							X	X	X	X	X	X

TABLE 4. EVALUATION ACTIVITY SCHEDULE

Script Evaluation Number	Activity
1	Intercom Terminations
2	Central Office and FTS Terminations at 12-Key Desk Sets
3	Private Line Terminations
4	Seattle ARTCC SS-1 Terminations
5	Tower SS-1 Terminations
6	Central Office, Foreign Exchange and FTS Terminations at 30-Key Consoles
7	Automatic Call Distribution to Preflight Positions
Nonscripted Evaluation Number	
1	Central Office Line Connectivity to Preflight Position No. 1
2	Foreign Exchange Line Connectivity to Preflight Position No. 1
3	Foreign Exchange Line Connectivity to Preflight Position No. 1
4	Call Transfer: Preflight Position No. 1 to Air/Ground
5	Simultaneous Inbound Central Office and Foreign Exchange Calls to Preflight Position No. 1

Tables 5 through 10 are included in this report to supplement table 3. The purpose of these supplemental tables is to:

1. Identify the number of tests accomplished for each discrete scripted evaluation;

2. Identify the evaluated positions applicable to the in-use script; and

3. Identify the evaluated lines and trunks.

Tables 11 through 16 illustrate in graphic format the results of evaluations 1 through 7 and are supplemental to tables 5 through 10. The relationship is as follows: tables 5/11, 6/12, 7/13, 8/14, 9/15, and 10/16.

Evaluation No. 7, ACD to PF positions, was a discrete, scripted evaluation of unquestionable significance and import to the evaluation team. The plan was to run this evaluation at least twice. Unfortunately, this was not possible. Activity management and scheduling, facility operations, and limited availability of test support personnel for assignment to 11 FSS operational positions and 9 distant (FX) locations were the reasons for being able to conduct evaluation No. 7 only one time. Figure 16 is a sequential record of this important activity.

A technical questionnaire was prepared for completion by the NAFEC test team members. This is included in appendix C.

OPERATIONAL RESULTS

GENERAL CONSTRAINTS.

It is very important to reemphasize the following conditions which had a significant and negative impact on this system evaluation:

1. The Portland FSS is a continuously operational facility.

2. Cutover from the previous communication system to the candidate WESCOM system was not preceded by an Operational Readiness Demonstration or a Joint Acceptance Inspection; therefore, this WESCOM system was assumed to be capable of servicing multiple and simultaneous incoming/outgoing calls via the several types of trunks and lines terminated at this facility.

3. This particular WESCOM system installation had, in the immediate past, evidenced a grade of service which severely impacted local FSS operations.

This WESCOM system installation was subjected to a series of semicontrolled evaluations conducted in the ongoing operational environment to determine whether or not this type of system evidenced generic qualifications for servicing telecommunication requirements of FSS's having an annual activity in excess of 400,000 service operations. Results are stated with respect to the CCS and the ACD.

TABLE 5. INTERCOM EVALUATIONS

Test	From	To	No. of Conferencing Positions
1	IF-1	PF-1	0
2	IF-1	PF-1	1
3	IF-1	PF-1	2
4	IF-1	PF-1	3
5	IF-1	PF-1	4
6	IF-1	PF-1	5
7-12	IF-2	PF-2	Same as Tests 1-6
13-18	IF-3	PF-3	Same as Tests 1-6
19-24	EF	PF-4	Same as Tests 1-6
25-30	FD	AC	Same as Tests 1-6
31	AC	FC	0
32	AC	FC	1
33	AC	FC	2
34-39	AC	EF	Same as Tests 1-6
40-45	FC	SEC	Same as Tests 1-6
46	AC	PF-1	10
47	AC	PF-1	11 (maximum capability)

TABLE 6. CENTRAL OFFICE/FTS EVALUATIONS USING 12-KEY DESK CONSOLES

Central Office Category

Test	From	To
1	FC 648-1022	Hillsboro AFS
2	FC 648-1022	Hillsboro Tower
3	FC 648-1022	Troutdale Tower
4	SEC 648-1022	Portland AFS
5	SEC 648-1022	Portland Tower
6	SEC 648-1022	National Weather Service

FTS Category

Test	From	To
1	FC 221-2330	Portland Tower
2	FC 221-2330	Troutdale Tower
3	SEC 221-2330	Salem Tower
4	SEC 221-2330	National Weather Service
5-12	FC 221-2675	NAFEC
13-19	SEC 221-2675	NAFEC
20*	FC 221-2675	NAFEC
	SEC 221-2330	Portland Tower

Notes: FC - Facility Chief's Desk Set

SEC - Secretary's Desk Set

* - Simultaneous line access

TABLE 7. PRIVATE LINE EVALUATIONS USING 30-KEY CONSOLES

Test	From	To
1	FBO/HA	EF
2	FBO/HA	FD
3	FBO/HA	AC
4	FBO/EF	EF
5	FBO/EF	FD
6	FBO/EF	AC
7	EF	NWS
8	AC	NWS
9	NWS	AC
10	AC	FBO/HA and FBO/EF
11	FD	FBO/HA and FBO/EF
12	EF	FBO/HA and FBO/EF

TABLE 8. ZSE SS-1 INTERPHONE EVALUATIONS

Test	From	To ZSE Sector
1	IF-1	The Dalles
2	IF-1	Hoquiam
3	IF-1	Toledo
4	IF-1	North Bend
5	IF-1	Portland
6	IF-1	Eugene
7	IF-2	The Dalles
8	EF	North Bend
9	EF	Eugene
10	EF	Portland
11	IF-3	Hoquiam
12	PF-1	The Dalles
13	PF-2	Hoquiam
14	FD	Toledo
15	PF-3	North Bend
16	PF-4	Portland
17	AC	Portland
18	AC	Eugene

TABLE 9. TOWER SS-1 INTERPHONE EVALUATIONS

Test	From	To
1	IF-1	Portland Tower
2	IF-1	Troutdale Tower
3	IF-1	National Weather Service
4	IF-1	Portland TRACON, North Sector
5	IF-1	Portland TRACON, South Sector
6	IF-1	Portland TRACON, Handoff Sector
7	IF-2	Portland TRACON, South Sector
8	EF	Hillsboro Tower
9	IF-3	Portland TRACON, Handoff Sector
10	PF-1	Hillsboro Tower
11	PF-2	Portland Tower
12	FD	Troutdale Tower
13	PF-3	National Weather Service
14	PF-4	Portland TRACON, North Sector
15	AC	Portland TRACON, Handoff Sector
16	AC	Portland TRACON, South Sector
17	AC	Portland TRACON, North Sector

TABLE 10. CO-FTS-FX EVALUATIONS USING 30-KEY CONSOLES

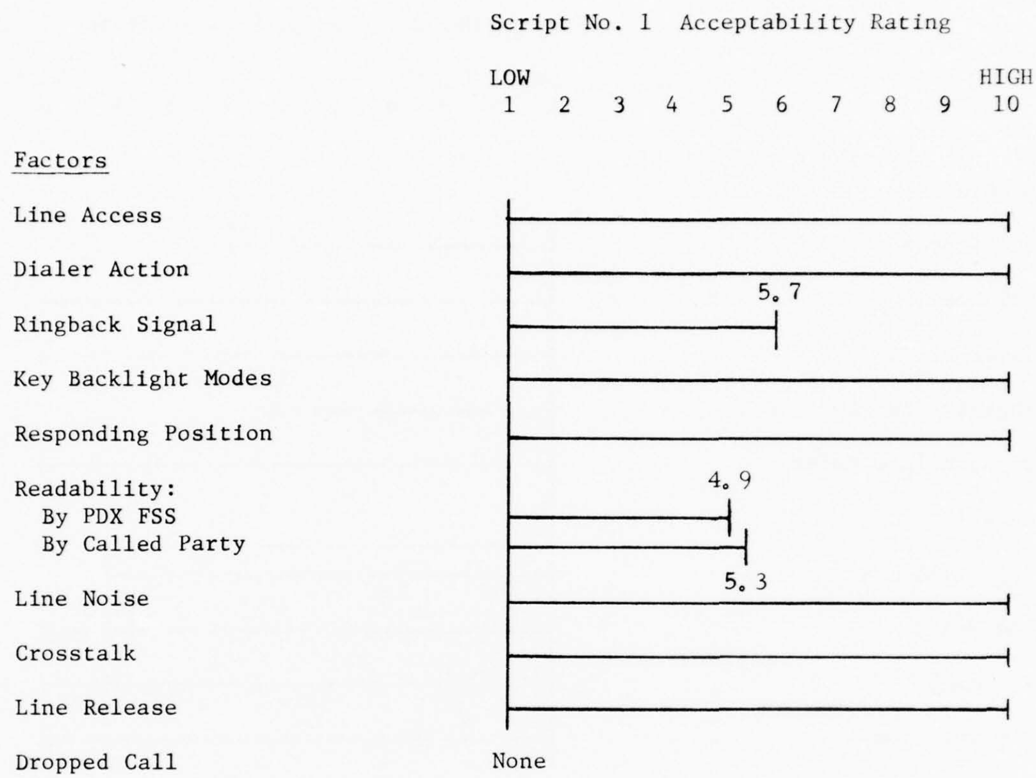
Test	From	To
1	EF 648-1022*	Hillsboro AFS
2	EF 648-2111*	Hillsboro Tower
3	EF 221-2675#	Portland Tower
4	EF 221-2330#	Troutdale Tower
5	AC 648-1022*	Hillsboro AFS
6	AC 648-2111*	Hillsboro Tower
7	AC 221-2675#	Troutdale Tower
8	AC 221-2330#	Portland Tower
9	FD 648-2111*	Hillsboro AFS
10	FD 221-2330#	Salem Tower
11	FD 222-1690@	AC 222-1699
12	FD 222-1699@	AC 222-1690

Notes: * Hillsboro Central Office Line

FTS Line

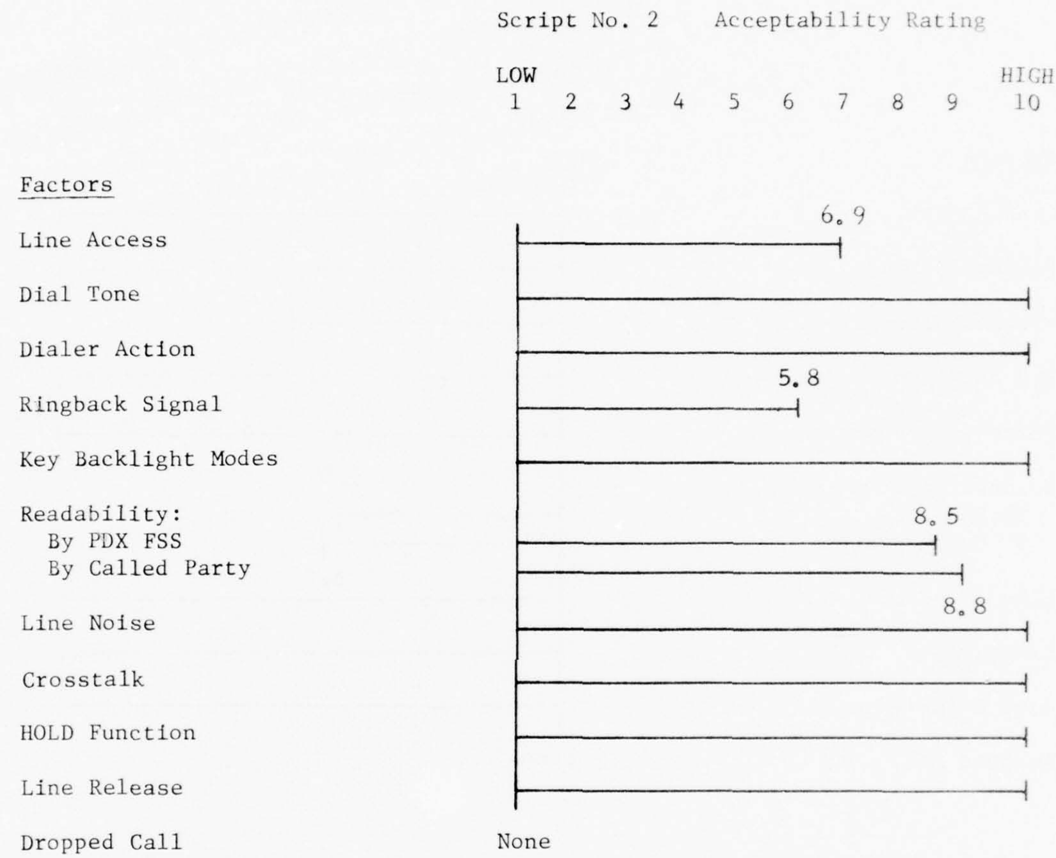
@ Foreign Exchange (FX) Line

TABLE 11. INTERCOM RATING FACTORS AND FACTOR ACCEPTABILITY RATINGS



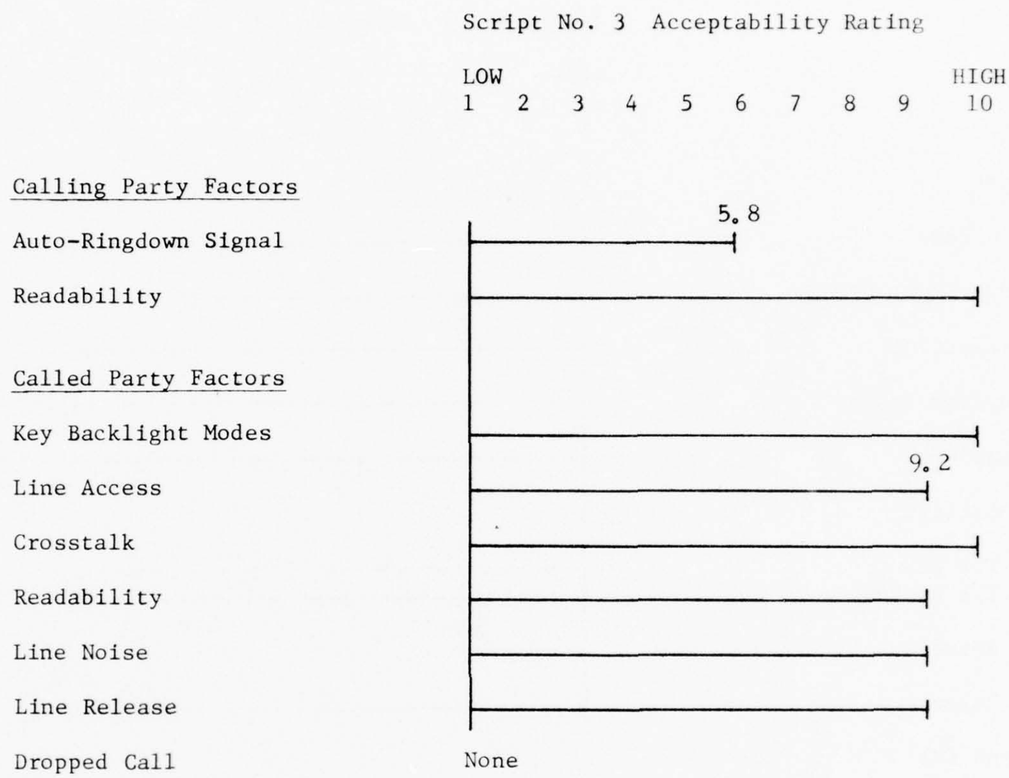
Averaged Rating: 8.59

TABLE 12. CENTRAL OFFICE/FTS RATING FACTORS AND FACTOR ACCEPTABILITY RATINGS



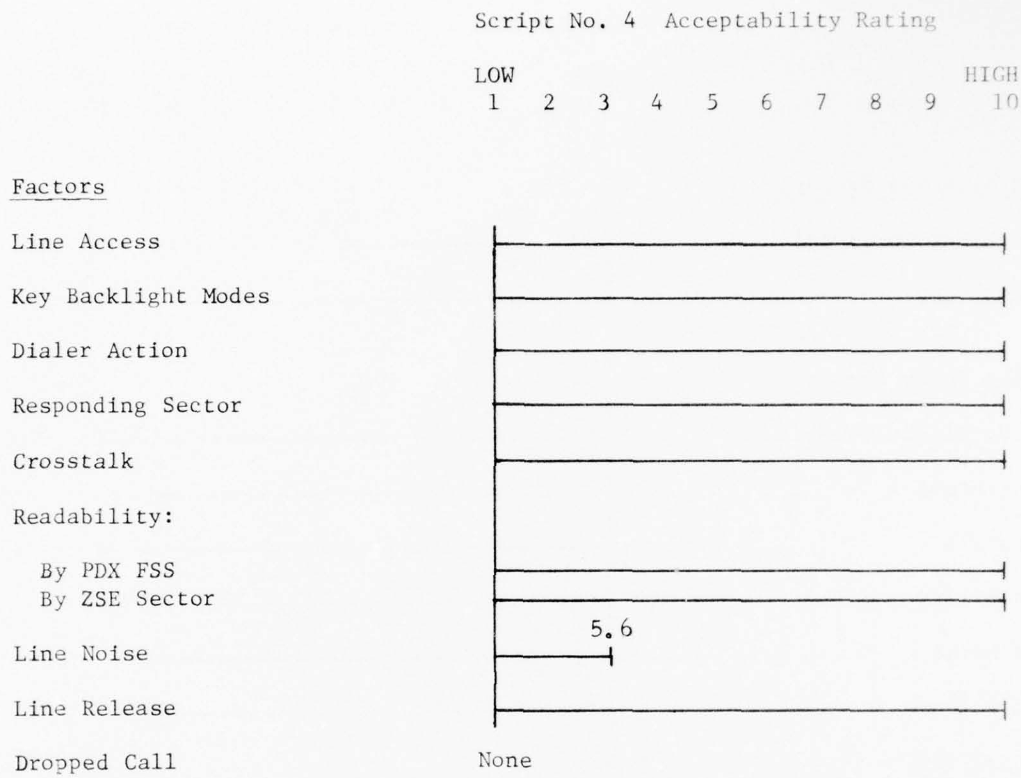
Averaged Rating: 9.09

TABLE 13. PRIVATE LINE RATING FACTORS AND FACTOR ACCEPTABILITY RATINGS



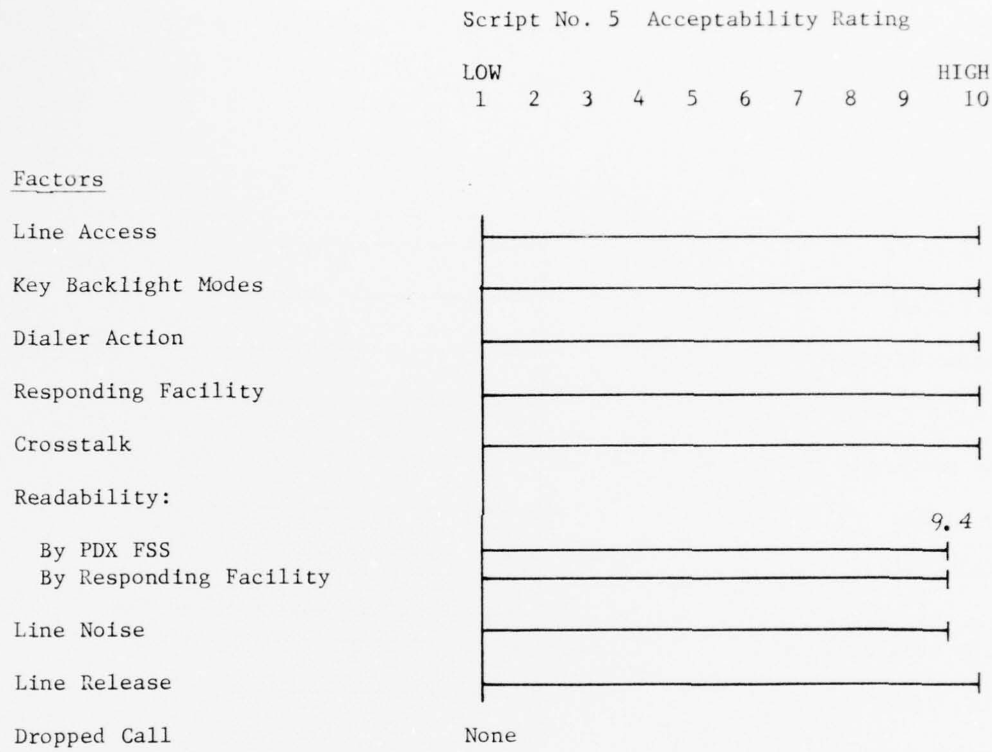
Averaged Rating: 9.07

TABLE 14. ZSE SS-1 INTERPHONE RATING FACTORS AND FACTOR ACCEPTABILITY RATINGS



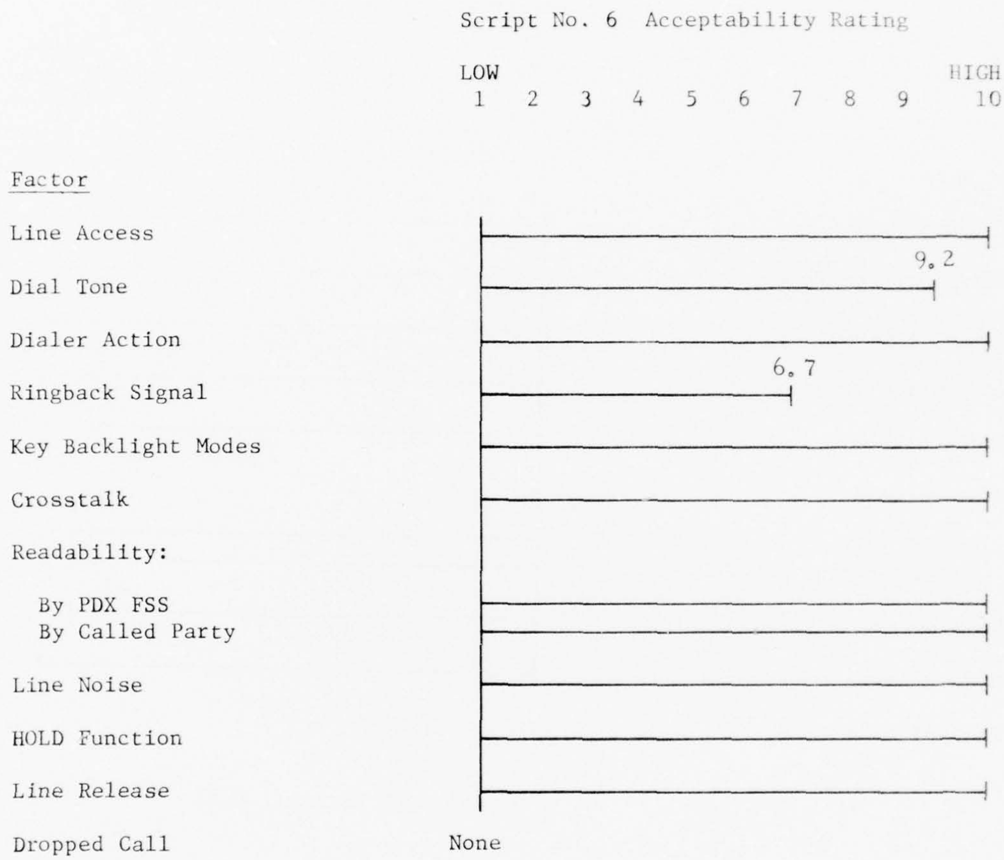
Averaged Rating: 9.51

TABLE 15. TOWER SS-1 INTERPHONE RATING FACTORS AND FACTOR ACCEPTABILITY RATINGS

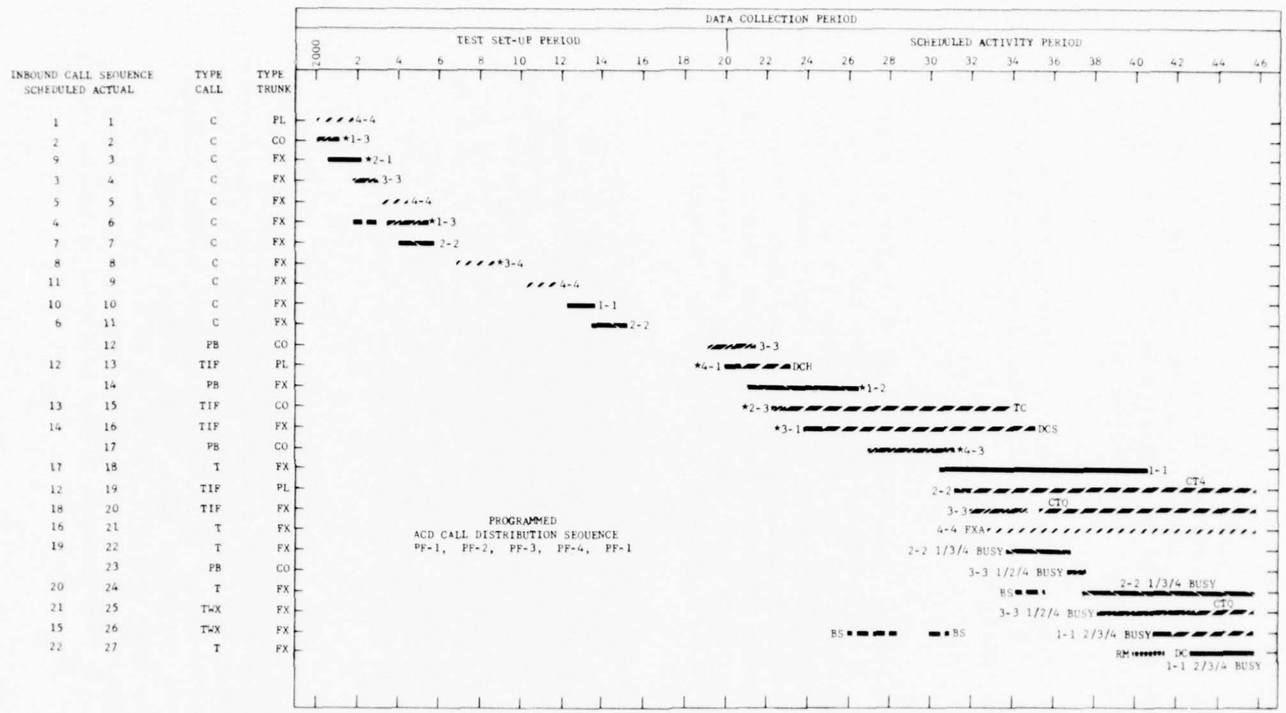


Averaged Rating: 9.91

TABLE 16. CO-FTS-FX 30-KEY CONSOLE RATING FACTORS AND FACTOR ACCEPTABILITY RATINGS



Averaged Rating: 9.62



CALL DURATION, PREFLIGHT POSITION #1
CALL DURATION, PREFLIGHT POSITION #2
CALL DURATION, PREFLIGHT POSITION #3
CALL DURATION, PREFLIGHT POSITION #4
DURATION OF RECORDED MESSAGE & STANDBY TIME
DURATION OF BUSY SIGNAL
DURATION OF CALL TRANSFER (CONNECTION OR QUEUE)

ACD AUTOMATIC CALL DISTRIBUTION: ANTICIPATED-ACTUAL (EX. 4-4)
BS BUSY SIGNAL: NO LOGICAL REASON
C TEST SUPPORT CHECK CALL
CO HILLSBORO CENTRAL OFFICE TRUNK 648-2111
CTO CALL ROUTED TO CALL TRANSFER QUEUE
CT4 CROSSTALK INVOLVING 2 CALLING PARTIES & 2 CALLED PARTIES
DC DROPPED CALL: NO LOGICAL REASON
DCH CALL DROPPED WHILE IN HOLD STATUS
DCS DROPPED CALL: UNINTENTIONAL DEPRESSION OF RLS KEY
FX FOREIGN EXCHANGE TRUNK
FXA OPERATOR ASSISTANCE REQUIRED
PB UNSCHEDULED PILOT BRIEFING CALL
PF PREFLIGHT POSITION (NUMBER)
PL PRIVATE LINE
RM RECORDED MESSAGE PLAYBACK: NO LOGICAL REASON
T TEST CALL SCHEDULED TO PREFLIGHT ONLY
TC CALL TERMINATED AT REQUEST OF THE TEST DIRECTOR
TIF TEST CALL SCHEDULED TO PREFLIGHT WITH SUBSEQUENT TRANSFER TO INFLIGHT
TWX TEST CALL SCHEDULED TO PREFLIGHT WITH SUBSEQUENT TRANSFER TO NATIONAL WEATHER SERVICE
* ACD DISTRIBUTED THIS CALL TO THE WRONG PREFLIGHT POSITION

76-11-16

FIGURE 16. ACD INBOUND CALL DISTRIBUTION TO PREFLIGHT POSITIONS

COMMON CONTROL SUBSYSTEM RESULTS.

The unstable evaluation environment, mandated noninterference with ongoing FSS operations, and necessary limiting of evaluation design and conduct combined to produce a minimal quantity of objective data and an overload of subjective data. Both types of data are displayed in composite bargram layouts in tables 11 through 16. Table 17 is a composite statistical layout of the bargram tables.

Reduction of data in these tables resulted in a mean acceptability rating for the Common Control Subsystem of 9.30. This rating is based on a scale ot 1 to 10 wherein the best possible rating is 10.0.

ACD RESULTS.

Scripted evaluation No. 7, Automatic Call Distribution to Preflight Positions, was conducted on October 16, 1975, between 2000 and 2046 PST. This evaluation was considered of utmost importance to the specific objective and to long-range planning. FSS operational activities during this test period amounted to three radio calls and four pilot briefing calls. This extremely light PF operation caused a most critical and severe impact on this controlled evaluation activity. The unscheduled pilot briefing calls completely disrupted the preconceived, time-oriented inbound CO-FX-PL call schedule as well as the integrated call transfer events schedule.

Test conduct required eight FSS specialists to be on duty at the FSS and 12 controllers (recruited from local area ATC facilities) to be on duty at FX remote sites, some sites being up to 50 miles in distance from Hillsboro, Oregon. Limited availability of test support personnel and FSS operational activity combined to allow but one test mission in support of evaluation No. 7. Figure 16 is a sequential record of this mission as determined by analysis of response received from each test support participant. Table 18 is a composite, statistical layout of responses received from the test participants. A mean average rating of 7.4, based on a scale of 1 to 10, wherein 10.0 is the best possible score, was determined for the ACD.

SYSTEM RESULTS.

System results are illustrated in table 19, WESCOM System Composite Factor Acceptability Ratings. Table content is a composite compilation of subsystem factors and factor acceptability ratings stated in tables 17 and 18. Consolidation of subsystem data for inclusion in table 19 resulted in establishment of a mean system acceptability rating of 7.88. This rating is based on a scale of 1 to 10, wherein the best possible rating is 10.0. Appendix B, "Response by Portland FSS Specialists to a Subjective Opinion Questionnaire," provides additional credence to the firmness of the established system rating.

TABLE 17. COMMON CONTROL SUBSYSTEM COMPOSITE FACTOR ACCEPTABILITY RATINGS

Factors	Acceptability Ratings Script 1	2	3	4	5	6
Line Access	10.0	6.9	9.2	10.0	10.0	10.0
Dial Tone	-	10.0	-	-	-	9.2
Ringback Signal	5.7	5.8	-	-	-	6.7
Key Backlight Mode	10.0	10.0	10.0	10.0	10.0	10.0
Readability:						
By Portland FSS	4.9	8.5	9.2	10.0	9.4	10.0
By Calling Party	5.3	8.8	10.0	10.0	9.4	10.0
Line Noise	10.0	10.0	9.2	5.6	9.4	10.0
Crosstalk	10.0	10.0	10.0	10.0	10.0	10.0
Line Release	10.0	10.0	9.2	10.0	10.0	10.0
Hold Function	-	10.0	-	-	-	10.0
Auto-Ringdown Signal	-	5.8	-	-	-	-
Responding Sector/Position	10.0	-	-	10.0	-	-

Number of Test Calls: 144

Number of Dropped Calls: 0

Average Rating Per Script	8.59	9.09	9.07	9.51	9.91	9.62

Mean Acceptability Rating for the Common Subsystem: 9.30

Note: Nonapplicable factors are indicated by the "-" symbol.

TABLE 18. ACD COMPOSITE FACTOR ACCEPTABILITY RATINGS

Factor	Number of Responses	Rating	Remarks
Line access; Calling Party	27	9.6	1 FX call required operator assistance.
Ringback Signal: Calling Party	27	8.9	Abnormal signal to one FX party; busy signal, without
Busy Signal: Calling Party	27	1.1	logical reason to 3 FX parties.
Recorded Announcement		@	1 FX party received a playback
Call alert signal to PF	27	10.0	
Call Sequence: In to ACD	27	@*	
ACD to PF	27	6.7*	9 calls misrouted to PF
Auto-Ringdown Signal	2	5.0	1 call dropped by ACD
Key Backlight Modes:			
At IF Positions	5	6.0#	
At PF Positions	27	10.0	
Call Transfer: To NWS	2	0.0	1 call not routed to NWS; 1 call received a busy signal, no logical reason
To IF	5	6.0#	
ACD Primary Queue		@	
ACD Transfer Queue		@	
Readability:			
By calling party	23	10.0	
By PF Specialist	27	8.9	Low voice level on 3 FX lines
By IF Specialist	5	6.0	Multiparty crosstalk
Crosstalk	27	8.5	Simultaneous mixture of 1-CO 2-FX and 1-PL calls
Line Noise	27	10.0	
Line Release	27	10.0	
Dropped Calls	34	9.1	3 calls: 2-FX, 1-PL
Average Rating		7.4	

Notes: @ No test due to four unscheduled pilot briefing calls.
* Scheduled call sequence disrupted by pilot briefing calls. Figure 12. indicates the probable inbound call sequence as determined by analysis of responses received from test participants.
\# 1 call dropped after being placed in hold; 1 call erroneously released by IF specialist; 1 call not answered by IF; two calling parties in simultaneous connection with both IF-1 and IF-2.

TABLE 19. WESCOM SYSTEM COMPOSITE FACTOR ACCEPTABILITY RATINGS

Operational Evaluation Factor	System Rating
Line Access	9.39
Dial Tone	9.60
Ringback Signal	6.75
Key Backlight Modes	9.50
Readability: By Portland FSS	8.36
By Calling Party	9.07
Line Noise	9.17
Crosstalk	9.78
Line Release	9.89
Hold Function	10.0
Auto-Ringdown Signal	5.40
Responding Sector/Position	10.0
Responding ATC Facility	10.0
Busy Signal	1.1
Call Alert Signal To PF Positions	10.0
Call Sequence: ACD To PF Positions	6.70
Call Transfer To National Weather Service	0.00
Call Transfer To IF Positions	6.00
Dropped Calls	9.10
Mean Acceptability Rating for the WESCOM System	7.88

TECHNICAL RESULTS

1. Test results show that a combination of design and equipment failures cause malfunctions in the Portland WESCOM system.

2. Automatic release of calls to the PF position by the ACD is not possible where battery feed on the loop start mode does not allow electrical determination of the on-loop state.

3. The ACD Status Panel counters do not in all cases keep an accurate count of PF position calls, or total calls.

4. The system's alarm signals are inadequate to notify FAA personnel of system failures, nor do they provide maintenance personnel with information necessary to make repairs.

5. System capacity of up to 128 trunks is more than adequate for large-size FSS facilities.

6. FSS maintenance personnel are not trained to maintain an integrated circuit ACD.

7. The system, at times, will malfunction without notice to users in such a way to totally inhibit its ability to accept incoming calls to the system.

8. Incoming trunks to the ACD can be tied up for long periods without detection by the users, thereby denying user access to the FSS.

DISCUSSION OF RESULTS

LOGIC PERFORMANCE.

The combined conditions of an in-use operational system under lease made offline testing to measure performance parameters impossible. Scripted testing was employed to determine exactly how the logic of the system operated, particularly under multiple-call conditions. Of specific interest were the performance of the delay message recorder and control logic, NWS transfer, A/G transfer, and the three queue functions.

During the period of onsite system test and analysis , degraded performance of the system was observed (appendix C), which could be attributed to either logical error in system design, fabrication error, or the integrated circuit logic chip failure. Examples of these conditions occurred as follows:

1. Incoming FX calls showed on the ACD Status Panel to be in HOLD mode while PF positions were idle. The condition of power failure was not noted by the "P" lamp being ON, but depression of the reset switch restored the system to normal operation (appendix C).

2. During the No. 7 test, two calls were transferred to each of two IF positions from PF positions, and all four transferred callers could talk to each other at normal audio level.

3. The NWS trunk could not be dropped by either FLASH or RLS keys. The drop could only be made by removal of the NWS transfer card from the bin.

4. Calls were dropped after being placed on HOLD.

5. Repeated disconnect of calls during pilot briefings.

6. Connection of trunks to PF positions following 120 V a.c. power disconnect when no trunk call was present.

7. Total calls count not equal to the sum of PF position counts; i.e., sum of 4 PF position counts = 23. Total call count = 5, abandoned = 1. The difference was 17.

8. "R" lamp failure to light under condition of Reading Bus being grounded.

9. Calls transferred from PF to IF were not always preceded by the transmission of a Call Alert signal to the IF position.

10. Failure to ring at FSS when NWS went off-hook while audio was heard at NWS from FSS.

11. Out of sequence distribution of calls to PF positions was recorded.

12. Failure to drop trunks after FLASH key was used.

13. ACD Status Panel lamps at half light level when in OFF mode.

14. Failure of trunk monitor lamp to light when call on PF position was transferred to A/G.

15. Failure of the "R" lamp and No. 1 bus lamp to indicate failure of trunk connection after 500 ms.

COMPLEMENTARY METAL-OXIDE SEMICONDUCTOR (CMOS) LOGIC.

The integrated circuit logic chips used in the system are mostly CMOS type. They are from several manufacturers including Texas Instruments, Motorola, and RCA. The CMOS chips are easily damaged from static electricity. The packaging of cards requires that they be conductive such as graphite-coated foam or aluminum foil wrap. Card removal from the rack must be carefully performed. The card should be grounded before removal, and the exposed terminal

of the card quickly shorted to prevent accidental pickup of charge. The electrostatic charges have extremely high voltages and low currents. The type of noise voltage occurring on the telephone should not reach the levels of static voltage. Line noise voltages should not be a problem; therefore, the CMOS is also recognized to have superior noise protection and rejection over Transistor-to-Transistor Logic (TTL) integrated circuits.

As the system makes heavy use of CMOS logic from the time of initial installation to test, there was a 15 percent failure of the chips. The loss of chips may be due to electrostatic charge or to the violation of the CMOS power rule. The power rule is:

"When separate power supplies are used for the COS/Metal-Oxide Semiconductor (MOS) device and for the device inputs, the device power supply should always be turned ON before the independent input signal sources, and the input signals turned OFF before the power supply is turned OFF ($Vss \leq V_1 \leq Vdd$ as a maximum limit). This rule will prevent overdissipation and possible damage of the D2 input protection diode when the device power supply is an open circuit. Violation of this rule can result in undesired circuit operation, although device damage should not result" (RCA COS/MOS Integral Circuits, 1975 Data Book Series).

The above rule relative to application of CMOS would appear to have been violated in the Portland WESCOM system, since the input signals are not interrupted before a shutdown of the +5 and ±15 V d.c. supplies.

The manufacturer, WESCOM, Inc., maintained that the MOS chip manufacturers were consulted prior to violating the power source rule and that chips should not be damaged. Of greater import was the use of extreme caution which must be taken in fabrication to prevent electrostatic damage. A new design has resulted in resistive protection on buses which would tend to reduce electrostatic charge damage.

WESCOM SYSTEM RELIABILITY.

Within the candidate WESCOM system there is no redundance of critical path elements. For instance, should a power supply fail, a replacement would have to be installed to put the system back in operation. During times of d.c. power supply failure, only certain CO and FTS lines would be operative, since they bypass the ACD. Again, failure of the control cards would also cause the system to go down without an alarm signal. Many other failures are possible without an alarm being given to either the ACD Status Panel or the equipment room. All alarm signals are visual.

The candidate WESCOM system design makes use of integrated circuits for improved reliability. However, problems of using the voltage sensitive logic may make its application in the telephone field difficult. Approximately 15 percent of the integrated circuits were removed due to failure after the system was installed at Hillsboro. The specific cause of these failures has not been established. Voltage spikes introduced to buses is suspected. Therefore, voltage spikes suppressors have been added to d.c. voltage buses. Confirmation of this cause/fix can only be produced by future field investigations.

Many of the cards have been field modified. Such modifications have been accomplished to provide for changed requirements, add-on features, or to correct logic or interface problems.

From the standpoint of increased performance and higher reliability, the introduction of large-scale integrated circuits is desirable for the planned ACD procurement. However, while the benefits are many, there are problems which must be considered. The Portland FSS ACD, built by WESCOM, has experienced severe logic failure problems for which there have been no solution which has been effective. As much as 15 percent of the integrated circuit chips had to be replaced because of complete or intermittent failure before the system became operational and ready for test. However, even during the test, there were persistent operational failures recorded which should not have occurred and that were due to technical failures. The reason for these failures has not been established by the FAA. It is unlikely that they may be determined until comprehensive technical tests are made using a solid state system interfaced to a telephone system.

LOGGED EQUIPMENT FAILURES.

During the 3 months preceding the onsite test and analysis by NAFEC, there were many instances of system failure recorded in the Portland FSS Operational Log (table 20). While the listing is extensive, it is probable that not all the instances of failure were recorded, particularly when the failure prevented callers from reaching the PF specialist. The log lists failures from July 11 to October 16. The date that the system was placed in operation was July 7. No system acceptance test was conducted prior to being placed in service.

As the entire listing is very long, the summary in table 20 provides a count of the most frequent failures. The count does not list the number of calls dropped or calls not forwarded, but the number of times an entry was logged noting the condition was occurring. Problem No. 8, ACD out of service, gives the total number of hours when the ACD was not distributing any calls to PF positions. IF positions were operational during this time.

ACD STATUS PANEL COUNTERS.

The ACD Status Panel counters were recorded for two dates and are listed in table 21. A difference between the sum and total of position counters shows a difference of 135 calls. This difference reflects logic problems in the ACD and may be, in some part, explained by the record shown in table 22. This shows that counter 2 advanced 2 upon receipt of a call on trunk 13 which was assigned to position 4. Counter 4 also advanced, but by 1 only. When this trunk was released, No. 4 advanced 1. However, when trunk 13 was released a second time from position 4, counter No. 2 advanced from 12 to 13. Another malfunction occurred upon release of trunk No. 9 when No. 4 counter advanced 1 to read 10226.

The count of 386 for abandoned calls must be considered suspect, since such a large number would most likely have resulted in verbal complaints to the Facility Chief. During the period of NAFEC testing, there is no record of any

TABLE 20. ACD FAILURE LOG, JULY 11 TO OCTOBER 16, 1975

Problem No.	Description	No. of Failures
1	Incoming calls not forwarded	25
2	Crosstalk at PF positions	12
3	Line out of service	31
4	Audio level low	15
5	ACD out of service	27.3 hrs.
6	Calls dropped	38
7	FX line not releasing	16
8	Transfer to NWS not working	7
9	ACD not distributing calls to a position	7
10	Incoming caller not able to get through	4
11	Call disconnected and switched to IF position	4

TABLE 21. ACD STATUS PANEL RECORD

COUNTER READINGS

Position No.	Date 10/13 Time 0200	Date 10/16 Time 1105		Counter Difference
1	24167	24524		354
2	16765	17237		472
3	12340	12376		036
4	10116	10534		418
			Total	1280
Abandoned	28134	28520		386
Total	57280	58309		1029
			Sum	1215
			Difference	135
Delayed	10937	11054		117

TABLE 22. ACD STATUS PANEL COUNTER

The following record of status panel counters was recorded on 10/14/75:

Trunk No.	Trunk Incoming	Trunk RLS	Counter Reading #2 16907	Counter Reading #4 10221
13	X		9	2
9	X		10	
5	X		11	
13		X		3
14	X		12	
13	X			4
13		X	13	
9	X			5
13		X		6

complaints of delays or abandoned calls. There were abandoned calls observed during the test, and the counter registered an appropriate advance for each; however, the number abandoned appeared to be small. A close track of abandoned calls is necessary, for which a confirmed accurate counter is required. The abandoned call most frequently occurs when the caller receives a delayed message announcement.

MAINTAINABILITY.

Monitor alarms are, with the exception of the P and R lamps on the ACD Status Panel located in the equipment room. The alarms are limited to the +5, -15, and +15 V d.c. power supply lamps and the two read bus alarm LED's. No other alarms are provided on the system.

The maintenance concept of GTE is to provide the local technician with spare cards and power supplies. Consequently, one each of the cards for the WESCOM system is to be provided. In the event of a failure, the fault is to be isolated through the 500-millisecond (ms) time-out and 1/2-second turn-ON of bus/LED. Detection of failure in any other system card is the technician's job after its operational symptoms have been observed by the FSS specialists. To assist the specialist in determining when a failure or malfunction has occurred, monitor LED's are provided for each trunk card.

When the trunk is waiting for connection to a PF, its monitor LED flashes. When connected, it changes to STEADY state. In the OFF state, the LED appears to be about half brightness and does not go to full "OFF." In addition, LED monitor lamps are provided to show status of the PF positions when "IN" lamps flash, but change to STEADY state when busy. The ACD Status Panel with LED monitor lamps is shown in figure 15. Additional monitor lamps are in the trunk cards. The lamp in the card lights when the trunk is connected through to a PF position. If it is delayed, it does not light until connected.

The monitor panel status lamps are the only means of readily detecting when the system calls are being unnecessarily delayed if the trunks are "hung up" and not connected to any PF position.

Onsite maintenance has been accomplished primarily by WESCOM design engineers and technicians. The principal test equipment used has been a dual-trace oscilloscope similar to the Hewlett-Packard (HP) model 180D. Use of the scope allows for chip performance monitoring.

The candidate WESCOM system is basically a logic system whose capability has been limited to that logic necessary to perform the control and storage functions of the call distributor and very limited alarms. The application of logic and memory to provide self-check features to the system have not been included. This would appear to be particularly important to confirm operation of the critical path functions such as the control cards. A failure in these cards may completely disable the system. The self-check capability of an ACD system is particularly important from the standpoint of maintenance. The FAA Technicians at the Portland FSS for instance, did not have training

in computer logic nor were they familiar with large-scale integrated (LSI) circuitry. The FAA technicians were limited in their solid state training and experience to that necessary to maintain the solid state communication equipment. The same problem existed with the GTE maintenance technician at Hillsboro. His solid state experience was roughly equivalent to the FAA personnel.

TRUNK INTERFACES.

The trunk lines for the Portland FSS WESCOM system are terminated in amplifiers which are used to adjust the signal level to 0 dBm. The system is capable of supervision which is either loop or ground start calling mode; however, certain of the loop start mode trunk lines originate from central offices which apply battery feed continuously. The NWS line is battery feed from that end, but the on-hook condition can be detected. To accomplish the proper line interface, an additional card must be added to the system.

The condition of the CO battery feed trunks can not be resolved electrically in the ACD. Consequently, the FLASH key is an essential key at FSS locations where CO provides this type of feed. At other locations, the ACD will automatically disconnect from trunk lines and deliver another call to the PF, if still on the "IN" status.

An alarm circuit has been added to the alarm card which will provide a 1/2-second alarm by lighting the bus 1 LED when an incoming call has failed to be connected to a PF position after 500 ms. This is the only circuit which would provide any indication to the maintenance technician that the problem existed.

EXPANSION POTENTIAL.

The expansion of the candidate WESCOM system is limited by economic feasibility and physical constraints of the particular design. The probable maximum expansion which should be considered is about 100 to 128 trunks. Above this number, larger capacity systems should be considered. Primarily, the system would become uneconomical as it becomes large.

CONCLUSIONS

Based on analysis of the factual and subjective data collected and presented in this report and appendices thereto, it is concluded that:

1. Joint Acceptance Inspection and Operational Readiness Demonstration testing of the WESCOM system installed at the Portland, Oregon, FSS was not accomplished by the Northwest Regional Office of the FAA or by the manufacturer.

2. Analysis of operational daily log reports for the 90-day period immediately preceding the evaluation period disclosed a significant number of derogatory ACD performance reports.

3. Facility specialists expressed a commonality of dissatisfied opinion with respect to system performance and reliability during the interim period between the date of commission and the start of evaluation testing by the NAFEC evaluation team.

4. The system was commissioned for operational use without the availability of a backup FSS ground-to-ground voice communication system.

5. The candidate WESCOM system did not function reliably, in that calls were dropped, missequenced to PF specialists, incoming calls were prevented from reaching specialists, and other related documented faults.

6. The introduction of any integrated circuit ACD not preceded by suitable testing in a nonoperational environment incurs a high risk of repetition of problems as encountered with the Portland FSS WESCOM prototype equipment installation.

7. Efficient accomplishment of Inflight and Preflight advisory services and activities during the evaluation period was impacted by dropped calls, missequenced calls, line release, and other documented faults.

8. Conduct of evaluation testing was constrained by FSS operational activies, which were noninterruptable, and by marginal performance of the telephone system. The effect of these constraints resulted in (1) a reduction in the number of planned test missions, (2) conduct of some test missions with less than desired loading of inbound calls to the system, and (3) a minimal retrieval of objective data.

9. Intercom service was provided to 15 attendant positions, but was limited to one ongoing two-party interconnection. Specialists at any one or all of the remaining 13 attendant positions could conference the ongoing two-party interconnection, but could not dial an outbound intercom call.

10. Intercom ringdown signaling at the called position's telephone instrument was a one-burst signal which, due to environmental noises, was frequently not heard by the called party. Ringback signaling to the calling party was not provided by the intercom system. The effect of these constraints did cause a negative impact on interposition coordination.

11. Line and function key operation (depressibility) was satisfactory. However. the keys were loosely fitted, and it has been experienced previously that this condition could lead to future problems wherein the specialist might have to depress a key two or more times before line access was actually accomplished.

12. Discrete line keys on each flush-mounted telephone console were backlighted. Light intensity was controllable through use of a rotary switch located on the console. Rotation of this switch simultaneously affected all line keys on the console. However, the switch did not provide stop protection against rotation beyond the lowest acceptable light intensity.

13. Key backlighting was under control of the CCS which provided three light display modes to indicate whether a line was in use, not in use, or in HOLD status. This set of modes was acceptable to the Portland FSS specialists, but should be expanded to provide two additional modes which are common to most ATC facilities. These modes are (1) line in use at this position, and (2) line in use at another position.

14. Discrete position call alert signaling to the Preflight positions is a beneficial ACD function.

15. Discrete position call signaling by ARTCC, Tower, and TRACON controllers to any operational position within the Portland FSS is not possible. Inbound calls from the ATC facilities activates a centrally located ringer device. The result is to cause all specialists to scan their telephone consoles to determine position responsibility for responding to the inbound call.

16. In accordance with requirements peculiar to the Portland FSS Flight Advisory Service, specialists assigned to IF, EF, FD, and AC attendant positions were able to dial outbound calls on those CO, FX, and FTS lines terminated at a discrete key on their telephone console.

17. Direct access Call Transfer to NWS and IF was accessible at each PF position. Frequency of use was minimal.

18. Sequential distribution of incoming CO, FX, and PL calls by the ACD to the PF positions, in general, is a beneficial system function which contributes to a more even distribution of the Preflight workload, but was not maintained on a continuous basis at the Portland FSS.

RECOMMENDATIONS

It is recommended that:

1. The candidate GTE/WESCOM Key/Automatic Call Distributor Communications System not be specified for high-activity FSS facilities.

2. Future prototype communications systems such as the candidate WESCOM system should undergo complete technical tests at NAFEC to insure satisfactory performance prior to field installation.

3. System failure indicators permit either operational or technical personnel to rapidly and efficiently identify and resolve problems.

4. Appropriate self-checking and readout devices for digital equipment should be available to both operational and technical personnel.

5. Training of FSS maintenance personnel should be extended to include integrated circuitry and digital logic.

6. Future ACD system designs should use standard LSI central processing units with random access and programable read-only memories so as to provide flexibility for function expansion while taking advantage of standard tested logic designs to reduce part count with subsequent increase in reliability.

7. Dead time before the playing of a delay message should be avoided, as should dead time following delay messages in order not to have calls abandoned.

8. The delay message should be used on transferred calls as well as incoming calls.

9. The nonresettable call counters on the ACD Status Panel should be replaced with resettable counters.

10. The electronic counters in the system should be automatically reset, and, for backup capability, the manual reset on the ACD Status Panel should be retained. The automatic reset would operate upon power failure or the condition of delayed calls with idle Preflight positions. A counter to record the number of resets is also recommended.

11. A status indicator should be provided on the ACD Status Panel to indicate when the delay message tape is playing. Failure of the Delay Message Recorder will result in a marked increase in the number of abandoned calls. The failed condition could exist until the public complained.

12. A "Delay Message Test" function key should be provided on the AC telephone console. Depression of this key would automatically cause the delay message to be played back through the telephone speaker on this console.

13. The system should include a "trunk drop" circuit which would be activated when a FLASH key is depressed and would cause the trunk to be held open long enough to insure trunk drop.

14. A set of LED Line Status indicators should be provided on each PF telephone console. The indicators would allow the specialist to determine line status following depression of the FLASH key and would also indicate call origin.

15. The capability of the Portland FSS intercom should be expanded to handle up to 10 ongoing two-party interconnections and these interconnections should be a discrete function of the CCS in lieu of service provided by a system interfaced with the CCS.

16. Intercom signaling should provide for continuous-until-answered ringdown at the called party end and continuous-until-answered ringback to the calling party.

17. Interposition coordination capability should be restricted to supervisory positions only.

18. Incoming call alert for any position in the Operations Room should be a chime tone emanating from a centrally located call alert device.

19. A call alert indicator should be provided on each telephone console.

20. A discrete chime tone should be considered for each type of operational position in the Operations Room.

21. Telephone position equipment intended for use in the Operations Room of an FSS should reflect the use of miniaturized state-of-the-art components such as volume controls, key dial unit, line and function keys.

22. Telephone consoles located in the Operations Room of an FSS should not include an air/ground radio speaker.

23. The RAD function key should not be included on the PF telephone consoles.

24. Controllers at the associated ARTCC and local area Tower/TRACON facilities should have selective access capability to the Inflight, EF, and AC positions.

25. The rotary dialer unit is time wasteful and should be replaced with a key dial unit.

26. The automatic call distribution function should be implemented for use at FSS Preflight positions only.

APPENDIX A

AUTOMATIC CALL DISTRIBUTOR

APPENDIX A

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LIST OF ILLUSTRATIONS

APPENDIX A

AUTOMATIC CALL DISTRIBUTOR

GENERAL.

TRUNKS AND POSITIONS.

The Automatic Call Distributor (ACD) receives incoming calls on Central Office, Foreign Exchange (FX), and Private Line (PL) trunks and distributes them to Preflight (PF) positions of the Flight Service Station (FSS). The positions are served in sequence, thereby distributing to nonbusy positions, while the last served position is bypassed whether still busy or not. If all positions are busy, the trunk carrying the next incoming call is identified, and its number is stored in a queue, with the caller informed of delay by a recording. If the waiting period exceeds an adjustable number of seconds, the recorded announcement is replayed to the caller until he disconnects, or the call is answered at a position. All trunks waiting for service are recorded in a stack memory or queue and processed on the first-in-first-served basis as positions become available. The system is provided with enough stack memory to store the addresses of all trunks simultaneously. A block diagram of the system is shown in figure A-1.

POSTS.

The incoming calls on trunks can be connected to Inflight (IF) and National Weather Service (NWS) lines (posts) through transfers operated from PF positions. All posts are divided into groups, with posts in any one group accessible through the same transfer. Each PF position is equipped with a NWS and an air/ground (A/G) transfer key. By pressing the key corresponding to the group chosen, the specialist serving the position transfers the calling trunk to one of the posts in the selected group. The post within the group is not selectable. Posts within one group are served in circular order, each trunk is switched to the next nonbusy post that follows the one last served (whether this last served post is still busy or not). Each post (IF position) has three PF keys to which three trunks may be transferred before a queue is started on transfers. If all the posts are busy, a waiting queue is formed. Each time a post becomes free, the trunk selected for connection to this post is the one that has been waiting the longest in transfer status, independently of the position from which the previous transfer was operated. The Portland FSS has adequate memory capacity provided to prevent overflow in the worst case of all trunks requesting the same transfer.

ALERTING.

OUTGOING. After the connection to a position or to a post has been completed, ringing signal is transmitted on the line, which results in a tone sounding at all posts. The ringing signal, 2-seconds-ON/4-seconds-OFF, is repeated indefinitely until the called party answers or the calling party hangs up. The NWS post receives the battery feed from the far end. The call from the ACD on that line is marked by loop closure.

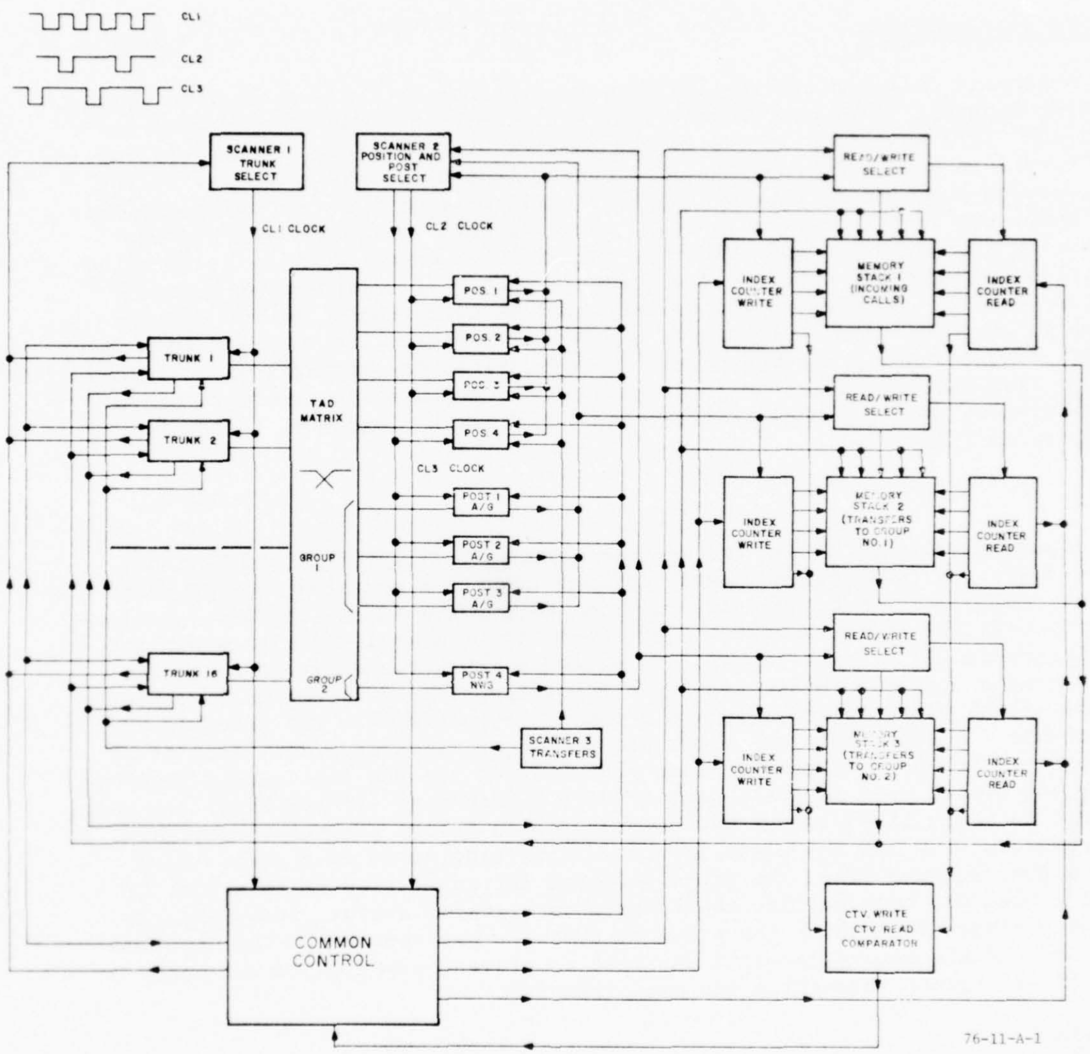

FIGURE A-1. BLOCK DIAGRAM GTE/WESCOM KEY/ACD COMMUNICATION SYSTEM

INCOMING. Each trunk can be equipped for either loop start or ground start calling mode. Loop start trunks for the Portland FSS employ a ring detector which closes the line loop and enables the d.c. voltage on receipt of a burst of ringing current. Three hundred milliseconds after detection of -48 volt of either polarity on tip and ring, the trunk is recorded in the stack memory for connection to a position. The choice of direct or reverse answer supervision is made by suitable strapping on each trunk card.

TERMINATION OF A CALL.

At any stage of the process, the connection is dropped 300 milliseconds after the opening of the loop at the Central Office (CO) or at the telephone end of the position or post line. A call waiting for transfer is invalidated when the calling party hangs up.

FUNCTIONAL DESCRIPTION OF THE ACD.

Figure A-1 shows the block diagram of the ACD for the Portland FSS project. The description contains many four or five number references in parenthesis which refer to schematics not included in this appendix.

SCANNER 1. Control Card No. 1 is employed in two modes: in Mode 1, it searches the trunks calling for service. In Mode 2, it identifies the trunk marked for co nnection by the readout from the stack memory.

Mode 1. When Scanner 1 finds a trunk calling for service, all scanners are stopped, and the writing routine is activated under the control of the binary mark issued from the trunk on a system bus (MEM WR). This mark selects and enables the write gates of the stack assigned to the group of positions or posts to which the call is directed. After the completion of writing the Index Counter Write (82/7,C) in Control Card No. 2 associated with the stack concerned, is increased by one to identify the address next to be filled, and the scanning of trunks is resumed.

Mode 2. In Mode 2, Scanner 1 is used as an element of the read routine. With one position or post marked for connection, the binary number of each successive trunk is compared to the content of the stack at the address indicated by Index Counter Read in Control Card No. 2 until the coincidence occurs and the scanner is stopped for the time necessary to fire the path from the trunk to the position or post. (The adoption of the sequential search, in preference to trunk selection by combinatorial logic, is the outcome of a compromise between speed and cost of hardware. Also, it makes the circuitry more readily adaptable to expansion for a greater number of trunks by extension of the memory elements built on optional plug-in cards.)

SCANNER 2. (81/1,B) of Control Card No. 1 consists of as many staggered subscanners as there are groups of positions and posts (the Portland FSS ACD has two subscanners). In time intervals, between calls, these subscanners are stopped, thus marking the posts and positions last served. As soon as the number of a trunk calling for service is recorded in the memory, the corresponding subscanner starts the search for the next available position or post

in the group concerned. At this stage, both Scanner 1 and one or more subscanners of Scanner 2 are running until a qualified position or post is found and the reading routine in the common control unit is activated. Now the scanning of Scanner 1 is changed from Mode 1 to Mode 2, and the path is fired after the search for the next-in-line trunk has been completed, as described under Mode 2. The subscanner remains stopped to mark the position or post last served (unless there is another trunk calling for service to the same group). This dual role of Scanner 2, used as line finder and a memory device allows a considerable economy of memory capacity and associated logic.

SCANNER 3. (82/2,B,C) of Control Card No. 3 selects the trunk for transfer as follows:

Pressing the transfer button on his console, the specialist marks the group to which the call is to be transferred. When Scanner 3 detects the position thus activated, it determines the trunk to be transferred by the intersection of two marks, doubling of the d.c. current in the Trigger Activated Diode (TAD) switch TAD path, and grounding of the system bus dedicated to the group of posts selected for reception of the transfer.

If the trunk is recognized as allowed to be recorded in the memory associated with the group ("wait latch" not set in the trunk), then the writing routine is initiated at the next scan of Scanner 1, as described in the "Mode 1" section. If this is not the case, Scanner 3 is stopped, and the trunk will remain marked for transfer until one of two things happens, the "wait Latch" in the trunk is reset, indicating that there is no valid record of the trunk in the stack assigned to the group, or Scanner 3 is reactivated, which occurs every second cycle of Scanner 1. In this case, the aborted transfer will be attempted at the next cycle of Scanner 3 unless the request for transfer has been invalidated by the originating party dropping the call.

STACK MEMORIES. (Control Card No. 2). Each group of positions and posts has an assigned stack memory, which contains binary numbers identifying trunks to be connected to the positions or posts of this group. Writing and reading in the stacks is controlled by the Index Counter Write and Index Counter Read, as described under sections "Mode 1" and "Mode 2". After each writing or reading operation, the corresponding counter is increased by one unit. The presence of a trunk eligible for connection is recognized by nonequality in the contents of the two counters. As soon as this nonequality is detected by a comparator associated with the counters, the corresponding subscanner of Scanner 2 starts the search for the next available position or post as described under Scanner 2. Should Scanner 1 detect another trunk calling the same group of positions or posts before Scanner 2 has initiated the firing routine (which is likely if all positions or posts in the group are busy), another trunk will be written on the stack, and the difference between the two index counters will be increased to two units. In this way the stack of waiting trunks can be built up to the full capacity of the memory.

WRITE AND READ ROUTINES. The common control unit contains the wired "Write" and "Read" routines.

Write Routine. The "Write" routine consists of five sequence states as follows:

WRITE SEQUENCE

State 1	State 2	State 3	State 4	State 5
1/2 cycle of the clock	1/2 cycle of the clock	1 cycle of the clock	1 cycle of the clock	1/2 cycle of the clock
All scanners are stopped. Read Routine is inhibited MEM WR Control Card No. 1	Write latch is set D,C) Control Card No. 1	Writing inlets to all memories are enabled. (KA MEMORY) The selection of the stack is made by the binary mark issued from the trunk on a system bus. (TRK MARK 1, TRK MARK 2)	Write Acknowledge pulse is transmitted to the trunks. "Wait latch" is set in the trunks. TAD path is dropped in case the operation is a transfer. Index Counter Write is increased by one. (WRITE ACK) Control Card No. 2	Write mark is removed. Time is allowed for the path to be dropped (if the operation is a transfer)

Read Routine. The "Read" routine consists of five sequences states as shown below:

READ SEQUENCE

State 1	State 2	State 3	State 4	State 5
1/2 cycle of the clock	1/2 cycle of the clock		3 steps of the clock	1 step of the clock
All Scanners are stopped. Write Routine is inhibited. C.C. No. 1	Read latch is set. (C.C. No. 1) Scanner in mode 2. The multiple reading outlet of the memories is enabled.	Scanner 1 searches the trunk to be connected to the position or post marked.	Path is fired through the TAD crosspoint	Connection complete (CON COMPL) pulse is transmitted to the common control. Index Counter Read is increased by one. C.C. No. 2

TRUNKS. The trunk circuit consists of the following units mounted on one standard PBX board:

1. Ring detector,
2. Answer supervision detector,
3. Line transformer,
4. Line relay A,
5. Ring relay R,
6. Recorder relay B,
7. Timer for recorded announcement, 10 seconds,
8. Timer for delayed calls monitor, 30 seconds,
9. Incoming calls mark control circuit with the associated "wait latch,"
10. Transfer mark control circuits with the associated "wait latches,"
11. Path control circuit,
12. Path current detector,
13. Path double current detector, and
14. Hold, release control circuit.

INCOMING CALL--RECORDING PHASE. At the end of the first burst of ringing current, relays K1 and K2 of the trunk are operated in that order, so that the trunk loop is never closed under ringing voltage. This arrangement helps to eliminate the danger of interference in the logic circuits mounted on the trunk card and improves the reliability of the telephone type contact R, which is always operated with the circuit open.

One hundred and fifty milliseconds after the detection of supervision from the Central Office (straight or reverse, according to the polarity of the optoelectronic device MCT-26), the holding of the relays A and R is transferred to the battery feed on the trunk line. Should supervision not be detected within this period of time, the latch associated with the ring detector of the trunk card will be reset, relays R and A will be dropped, and the trunk will be ready to receive another call.

In case of a valid call the writing routine is initiated (MEM WR) at the next scan of Scanner 1, as described under Mode 1, and the "wait latch" of the trunk card is set to mark the presence of the trunk number in the memory dedicated to incoming calls. As long as the "wait latch" remains set, another record of the trunk in the same stack is prevented.

FIRING OF THE CROSSPOINT PATH FROM THE TRUNK TO THE STATION. In response to the COMPOUT mark, issued from the comparator associated with the stack indexes, Scanner 2 starts the search for an active and nonbusy station circuit. Except in the case of all stations busy, the selected station will be the first qualified station that follows the one initially marked by Scanner 2. The run of Scanner 1 is now changed from Mode 1 to Mode 2, and the reading routine is activated as described under section WRITE AND READ ROUTINES. The completion of the search for the trunk number matching the stack readout is marked in the trunk by the coincidence:

TRK SCAN = "1"
FIRE BUS = "1"
Read BUS1 = "0"

The path to the station is fired, latched, and acknowledged (CON COMPL) to the Common Control. At the same time, the "wait latch" is reset, and the trunk is ready to be recorded in the stack when the Central Office calls again. If the calling party hangs up before the connection to the station has been made (for example, with all stations busy), and the number of the trunk comes up for service while the trunk loop is in "on-hook" status, the operations described in this section are carried out unchanged, except that the control circuit will remain disabled and the path to the station will not be fired. The abortive call of this kind will be included as a valid step in the call sequence to the specialists.

If the trunk recorded for an incoming call hangs up and calls again before its number has come up for service, the "wait latch" inhibits the writing routine, so that each trunk number cannot have more than one valid appearance in the stack. Moreover, the memory record remains unchanged, and, consequently, the calling party benefits from the original waiting number, as if the trunk had not been dropped after the first call.

TERMINATION OF A CALL AND RELEASE OF THE CROSSPOINT PATH. When supervision is removed from the Central Office for 300 milliseconds, relays K1 and K2 are released in that order, so that the telephone-type contact R is operated with the trunk loop open, and the interruption of the loop current occurs in the mercury-wetted contact only. The drop of the crosspoint path follows after the time determined by the delay circuit associated with MCT-26 of the trunk card.

When the call is released at the station end, the crosspoint path is dropped in the line circuit, and the hold latch in the trunk card is reset through the path current detector.

When the call is released after request for transfer on the trunk card, the hold latch remains in the "busy" status, and the path control circuit is disabled through the flip-flop.

CALL FOR TRANSFER. A call for transfer is handled in the same way as an incoming call as described under FIRING OF THE CROSSPOINT PATH FROM THE TRUNK TO THE STATION, but the identification of the trunk is now derived from the mark of Scanner 3 and not from loop supervision. When the request for transfer is detected in a position circuit, in which the transfer latch has been set by the specialist pressing the transfer key on his console, under section SPECIALIST TRANSFER (POSTS), Scanner 3 is stopped, the system bus TRANS GR1 or TRANS GR2 is marked, and the crosspoint current is increased from 30 milliamperes (mA) to 60 mA. As soon as Scanner 1 detects the double current in the trunk card, the writing routine in the Common Control is initiated, as for a call, to positions described under INCOMING CALL--RECORDING PHASE. However, instead of being recorded in the stack dedicated to incoming calls, the number identifying the trunk is now recorded in the stack dedicated to the group selected for transfer. When the end of the writing routine is acknowledged on the WRITE ACK bus, the crosspoint path is dropped, and the "wait latch" is set to prevent the multiple appearance of the trunk number in the stack and also to inhibit the completion of the recorded transfer if the calling trunk drops the call and comes back on the line with, perhaps, another subscriber requesting, this time, another transfer. This transfer inhibit associated with consecutive calls to different posts is removed if--on request of the calling party--the attendant renews the same transfer on the second call.

The call history in each of the above cases is summarized in figure A-2.

LINES. The Portland FSS/ACD employs three types of line circuits, all mounted on the same basic printed circuit board and differing from one another by the components inserted into the board:

PREFLIGHT LINE CIRCUIT (POSITION CIRCUIT). Consists of the following elements mounted two per standard Private Branch Exchange (PBX) board.

1. Call for service detector,
2. Loop supervision,
3. Transfer latches,
4. Line transformer,
5. Battery feed,
6. Ring relays,
7. Path control circuit,
8. Path current detector, and
9. Path double current detector.

Firing of the Crosspoint Path. As soon as the nonequality of the Index Counter Write and Index Counter Read contents is detected by the comparator of Control Card No. 2, Scanner 2 selects the next nonbusy, activated position circuit marked on the COMP OUT bus, and initiates the reading routine as described under section "Read Routine" through the READ bus of the line card extended to all trunks and the Common Control unit. At the same time, on the line card the path control circuit is enabled, and the Field Effect Transistor (FET) switch which grounds the matrix lead as long as it is idle is opened.

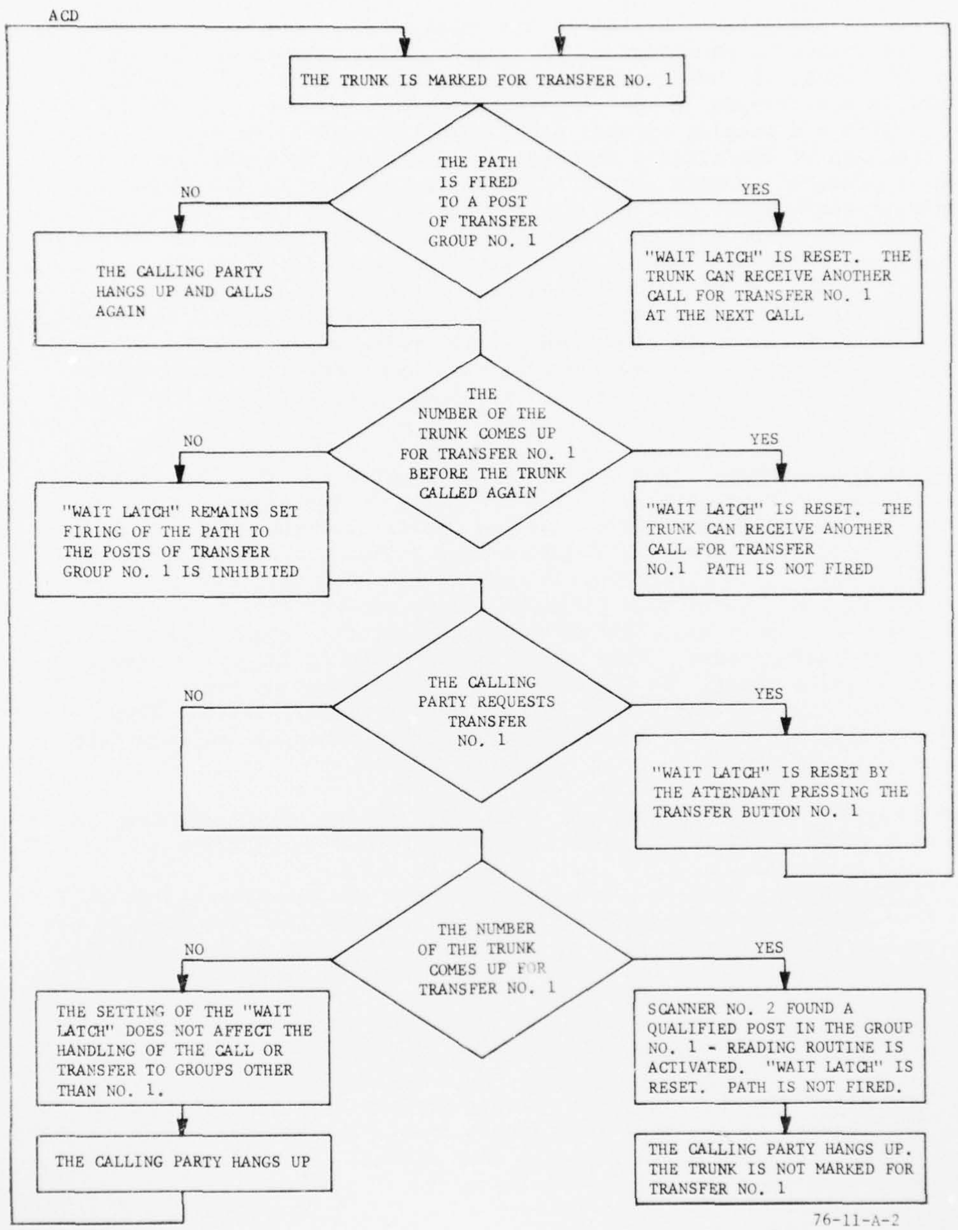

FIGURE A-2. ACD FLOW CHART

The source of the crosspoint current is now ready to fire and waits for the sink end in the trunk to be connected to ground. When this is acknowledged on the CON COMPL bus, the busy latch is set, the READ bus mark is removed, and the ring relays are tripped in two stages: first, the telephone-type relay RD is closed with the ringing circuit open, then the read relay P is closed at a zero crossing of the ringing current, as determined by a periodic PH CONT pulse produced at each zero of the ringing current in the Common Control unit of the control card and distributed on the PH CONT bus to all line circuits. This two-step operation protects the logic circuits on the line card against sparking in the RD contact, which would be prohibitive if this contact was allowed to bounce in the unfavorable phase of the ringing voltage. As the PH CONT bus affects all lines, each P relay is provided with a fail safe lock, which will hold it permanently closed should the pulse train fail out or fall below a safe peak level. Such failure will give the alarm equivalent to "no ringing voltage." Most calls will still be processed correctly in the time necessary to remove the fault.

Ring Trip and Release. When the called party answers, the loop supervision circuit of the line card removes the ringing in two steps: first, the P read contact is released at a zero crossing current (if the trip occurs during ringing phase), then the R telephone-type contact is released with the ringing circuit open. (The most critical case is the back trip at the maximum of ringing voltage on a short line with the telephone "off hook," resulting in the discharge of the ringer capacitor into the battery feed by-pass capacitor in the line circuit. This can occur when the calling party hangs up during the ringing phase. At the same time, the crosspoint path is sensitized to the loop current by the setting of the release latch. When the position releases the call, the crosspoint path is dropped following the reset of the release latch.)

If the ringing is not cut short by the answer of the called station, the back trip will occur after the time determined by the delay circuit.

Call for Transfer. When the specialist presses the transfer button while connected to a trunk, the corresponding transfer latch of the line card is set, and the transfer sequence starts at the next scan of Scanner 3 as described under section TERMINATION OF A CALL AND RELEASE OF THE CROSSPOINT PATH.

As soon as the path has been dropped, following the record in the stack, the station is ready to receive another call without opening of the line loop.

SPECIALIST TRANSFER (POSTS). The post circuit differs from the position circuit by the absence of the transfer latches double current control and ring timer. Otherwise, the working of the post circuit is the same as described under section "Ring Trip and Release."

ACD INTERFACE (POST WITHOUT BATTERY FEED). This circuit differs from the post circuit by the absence of the battery feed and the ringing current source. Otherwise, the working of the ACD interface is the same as described under section SPECIALIST TRANSFER (POSTS).

ALARMS. The following luminous alarms are displayed on the alarm panel (figure A-3):

	+ 5 V Power Supply
	+15 V Power Supply
	-15 V Power Supply
Read Bus 1 -	alarm given if the bus is permanently grounded
Read Bus 2 -	alarm given if the bus is permanently grounded

CAPACITY.

Number of trunks:	25, extendable to 105 trunks by addition of one control card;
Number of positions:	9, extendable to 80 by addition of one control card;
Number of groups of posts:	2, extendable to 30 by addition of one associated card per trunk card.
Number of posts:	9, extendable to 80 by addition of one control card.

SHELF 3

1	TRUNK RELAY INTERFACE
2	TRUNK RELAY INTERFACE
3	POSITION BUSY INTERFACE
4	TRUNK COUNTER INTERFACE NO. 2
5	TRANSFER CONTROL INTERFACE
6	TRUNK COUNTER INTERFACE NO. 1

SHELF 2

1	TRUNK 5
2	TRUNK 6
3	TRUNK 7
4	TRUNK 8
5	TRUNK 9
6	TRUNK 10
7	TRUNK 11
8	TRUNK 12
9	TRUNK 13
10	TRUNK 14
11	TRUNK 15
12	TRUNK 16

SHELF 1

1	CONTROL CARD 1
2	CONTROL CARD 2
3	ATTENDANT LINES 1 & 2
4	ATTENDANT LINES 3 & 4
5	ATTENDANT LINES 5 & 6
6	ATTENDANT XFER 1 & 2
7	ATTENDANT XFER 3 & ARD INTERFACE
8	TRUNK 1
9	TRUNK 2
10	TRUNK 3
11	TRUNK 4
12	X-POINT MATRIX
13	REC. INTERFACE
14	ALARM PANEL

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FIGURE A-3. ACD LOGIC CARDS FOR SHELVES 1, 2, AND 3 OF BAY NO.2

APPENDIX B

RESPONSE BY PORTLAND FSS SPECIALISTS
TO A GENERAL QUESTIONNAIRE

APPENDIX B

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LIST OF ILLUSTRATIONS

APPENDIX B

RESPONSE BY PORTLAND FSS SPECIALISTS TO A GENERAL QUESTIONNAIRE

INTRODUCTION.

The design and intent of the appended general questionnaire was to gain operational comment pertinent to the WESCOM Key/ACD Communication System in continuous usage at the Portland FSS and, to solicit the FSS specialists for generic comment relative to requirement and design of an FSS voice communication system that would significantly enhance the mission of Preflight specialists working at high-activity FSS's.

This questionnaire is divided into seven parts, Parts A to G. Essentially, the questionnaire sets forth operational oriented questions. Where necessary, technical oriented questions, not above the comprehension of the specialists, are included.

The questionnaire was completed by 22 Portland FSS specialists during their free time after the NAFEC evaluation team had returned to its headquarters. The appended questionnaire is in original format, but the number of pages has been reduced by elimination of space previously allowed for response to a given question.

Review of the 22 returned questionnaires, in many instances, showed a commonality of response to a specific question. Also, some specialists provided more than one response to a specific question. Thus, the reader is forewarned that many parenthetical tabulations in the appended questionnaire are not to be indicative of more than 22 specialists completing this questionnaire.

Responses to each question are stated in verbatim form and are preceded or followed by a parenthetical number. This number represents the number of specialists who made the same response. It is unfortunate that only a few specialists provided commentary for their response. However, verbatim commentary or the words "No Commentary" are indicated where appropriate.

GENERAL QUESTIONNAIRE

Part A: WESCOM Consoles

1.0 Three types of WESCOM consoles are in use in the Operations Room: Preflight, Inflight, and 30-key consoles. For each type console, identify those keys which you feel are unnecessary to effectively and efficiently perform your assigned responsibility while using a particular console type. Your response should identify the unnecessary key as it is tabbed on the console and should include a brief narrative report as to why you consider a key to be unnecessary.

1.1 Preflight Console

Intercom Key	(4)	No Commentary
Radio Transfer Key	(18)	" "
COAM Key	(1)	" "
Ring Key	(1)	" "
Air/Ground Transfer Key	(5)	Unintentional depression of the Air/Ground Key instead of the IN Key.

1.2 Inflight Console

Preflight Key	(9)	No Commentary
Intercom Key	(2)	" "
Radio Transfer Key	(1)	" "

1.3 30-Key Console

Intercom Key	(2)	No Commentary
Fixed Base Operator Key	(1)	" "
Ring Key	(2)	" "
COAM Key	(2)	" "

2.0 This question is the reverse of question No. 1. Are there line and/or function key requirements that should be made available to the specialist?

2.1 Using a Preflight Console

Hotline to Fixed Base operators located in Portland and Salem.	(1)
Hotline to U.S. Customs located in Portland.	(1)
Line status indicators are required	(2)
Outbound call capability on a CO line.	(2)
Interposition CO-FX-PL Call Transfer capability.	(8)

2.2 Using an Inflight Console

Fixed Base Operator Key.	(2)
CO capability to U.S. Customs and Military.	(1)
Interposition CO-FX-PL Call Transfer capability.	(3)
Hotline to Fixed Base operators in Portland and Salem.	(1)
30-key console at Inflight positions to provide backup service for Preflight positions.	(3)

2.3 Using a 30-Key Console

CO capability other than 648-2111.	(1)
Call transfer capability to National Weather Service.	(12)
Call transfer capability to Assistant Chief.	(2)

3.0 This question relates to the following human factors: console design and utility, key size, spacing, arrangement and operation, visual/aural alert signals, key backlight, dialer operation, key identity, reflection of light from overhead fixtures, volume control switch, and light control switch. If you have comment pertinent to these factors or to factors not included in the above listing, please provide comment as follows:

3.1 Relative to the Preflight Console

Floor-to-ceiling partition between Inflight and Preflight to reduce noise level.	(1)
Offset WESCOM console and clock to provide room for display of pilot briefing material.	(1)
Volume control for headsets.	(5)
Eliminate incoming call alert switch.	(1)
Need discrete line volume controls at each position.	(5)

3.2 Relative to the Inflight console

Volume control for headsets.	(4)
Need discrete line volume controls at each position.	(4)
Eliminate incoming call alert switch.	(1)
Floor-to-ceiling partition between Inflight and Preflight.	(1)

3.3 Relative to the 30-Key Console

Volume control for headsets.	(5)
Need discrete line volume controls at each position.	(5)
Eliminate incoming call alert switch.	(1)

Part B: Key Backlight and Service

2.0 It is believed that each specialist is familiar with the term "Key Backlight." A more appropriate term is "Line Status Indicator" which, at any given moment, will visually display one of five light mode signals:

STEADY	-	Line in use at another position
FLUTTER	-	Line accessed from your position
FLASH	-	Incoming call to your position
WINK	-	In-progress call at your position is in HOLD status
OFF	-	Line can be accessed from your position

2.1 Do you have difficulty in being able to distinguish between the FLUTTER, FLASH, and WINK modes? Yes (10) No (10)

2.2 Do you feel that the WESCOM system does not include the FLUTTER and FLASH modes? Yes (11) No (9)

2.3 At what point do you generally set the Key Backlight Intensity Control switch (a rotary switch)?

(8)	10 - 25 percent intensity	(6)	40 - 55 percent intensity
(2)	25 - 40 percent "	(3)	55 - 75 percent "
		___	Above 75 percent "

2.4 If your answer to 2.3 does not generally apply to the several positions of operation with the Operations Room, please give details below:

2.4.1 Preflight Positions 1 and 2

No response.

2.4.2 Flight Data Position

No response.

2.4.3 Preflight Positions 3 and 4

No response.

2.4.4 Inflight Positions 1 and 2

No response.

2.4.5 EF Position

No response.

2.4.6 Assistant Chief's Position

No response.

2.4.7 Inflight Position No. 3

No response.

2.5 Do you feel that you are able to give better service to the public through use of the WESCOM system? (Note: This question is generally applicable to all three types of WESCOM console equipments.)

Yes (11) Why?

No explanation.	(3)
Preflight can handle more calls.	(1)
If and when system operates normally.	(3)
When the bugs go away.	(2)
Low noise level in the Operations Room.	(1)
System is much faster.	(1)
Less friction between specialists.	(1)

No (10) Why?

System is very unreliable.	(4)
System is manpower wasteful.	(1)
Inordinate number of lost calls.	(4)
Call transfer to National Weather does not work.	(1)
Noncompatible types of telephone lines.	(1)
Lines will not release.	(1)
Headset earpiece falls out.	(1)
Inflight cannot provide backup service to Preflight during periods of high workload.	(1)
Connects a calling party to two Preflight positions.	(1)
Misrouted calls.	(1)
Look elsewhere for a reliable system.	(1)
Connects two positions to one line.	(1)
Headsets are very impracticable.	(1)
Frailty of system.	(1)

2.6 On the assumption that you have received complaints from the public about this telephone system, what in your opinion are the more frequently reported faults and/or situations?

Dropped calls.	(11)
Voice level of calling party is too weak.	(5)
Inbound call is not sent by ACD to Preflight.	(4)
Lines are always busy.	(1)

Calling party hears a busy signal when, in fact, one or more Preflight positions are awaiting a call.	(2)
Calls are abandoned because calling party did not get a playback of the delay message recording.	(4)
Misdirected calls.	(1)
Calls are abandoned because calling party did not get a repeat playback of the delay message recording.	(1)
Dead line.	(1)
Calls are abandoned because calling party cannot understand what is being said.	(1)
Calls are abandoned because calling party does not receive a noise-free playback of the recorded message.	(3)

2.7 With respect to your response to question 2.6, is there a possibility that your headset may have been a contributing factor?

No (15)
Yes (4) Why?

Plantronic audibility is no good.	(3)
Prefer to use handsets.	(4)
Headset is not designed to comfortably accept eyeglasses.	(1)
Need custom-fitted earpieces.	(2)
Faulty wiring in headset.	(1)

Part C: Preflight Position Consoles

1.0 When assigned to a Preflight position, would knowing the origin of an incoming call be more beneficial to a more efficient and effective accomplishment of the FSS mission? (Note: consider, as one thought, those times you have had to ask the Assistant Chief to take over a call you were handling.)

No (5).
Yes (14). Why?

Call origin, generally, relates to the point of departure.	(1)
For line identity to Assistant Chief.	(8)
Provide call transfer capability to all positions	(1)
Knowledge of call origin cuts down briefing time.	(5)
To immediately know departure area and/or airport.	(5)

2.0 Should each Preflight console be equipped with a Call Transfer Key to route a call to the Assistant Chief's position?

No (3). Why? No commentary.
Yes (16). Why?

AD-A033 052 NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER ATL--ETC F/G 17/2
OPERATIONAL AND TECHNICAL ANALYSIS GTE/WESCOM KEY/AUTOMATIC CAL--ETC(U)
NOV 76 R K OHMAN, E M SAWTELLE

UNCLASSIFIED FAA-NA-76-11 FAA-RD-76-148 NL

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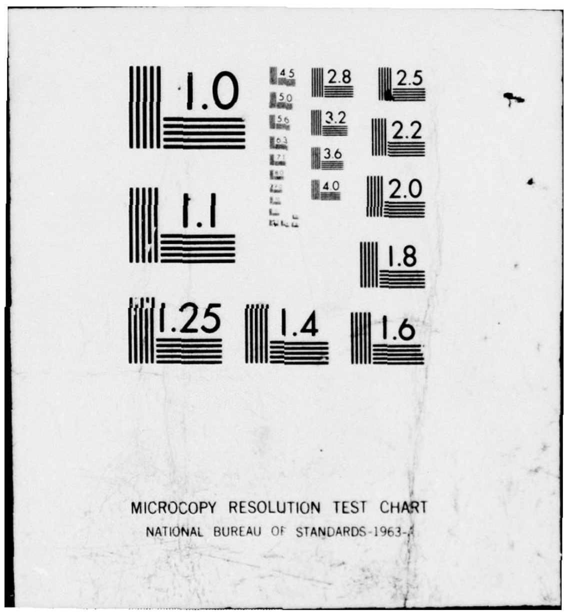

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

To reduce noise level in the Operations Room.	(6)
Many calls on IN Key are for the Assistant Chief.	(11)
To preclude tying up Preflight.	(3)
Intercom system takes too long.	(2)
All CO-FX-PL calls are answered at Preflight.	(1)
System improvement.	(1)
Eliminate the requirement to ask for call origin on those calls which you must transfer to the Assistant Chief.	(3)

3.0 Should the Assistant Chief be able to transfer calls to Preflight positions?

No (4). Why?

May be required at other Flight Service Stations.	(1)
If equipment operates as designed.	(1)
Should not be necessary.	(2)

Yes (13). Why?

Assistant Chief cannot transfer a call to Preflight.	(2)
All CO-FX-PL calls should be transferable within the FSS.	(3)
To relieve the Assistant Chief from having to take lesser priority calls.	(2)
Requirement to talk to a specific person.	(2)
Assistant Chief does not have immediate access to pilot briefing materials.	(4)

4.0 When answering an incoming call on a Preflight console IN key, do you ask the calling party where he is calling from?

Never (0) Sometimes (12) Frequently (6) Always (2)

5.0 When two or more specialists are on duty at the Preflight positions, do you feel that incoming calls are equally distributed to each specialist?

No (4). Why?

Line release problems.	(2)
Systems errors.	(2)
By experience, four successive calls routed to Preflight No. 1 when Preflight 2, 3, and 4 were not busy.	(2)

Yes (16). No commentary.

6.0 A calling party will get a Delay Message when all active Preflight positions are connected to other calling parties. Currently, the Delay Message is a very short message without any form of "station identity" such as "Portland Flight Service." Should this identifier or a more appropriate identifier preface the recorded message thus assuring the calling party of (1) called party identity, (2) receipt and impact of the complete recorded message.

Yes (16) Why?

Due to above stated reasons.	(6)
Calling party is already stating his request when Preflight responds to an inbound call signal.	(3)
Message should state "This is a recording."	(4)
Pilots automatically think message is a briefing special.	(3)
Music would hold the calling party's attention.	(1)
Preflight positions are busy.	(2)

No (1). Why? (1)

Message is sufficient. (1)

7.0 When after transferring a call to NWS or to IF do you later find that the call was dropped?

Never (0); Rarely (7); Sometimes (10); Frequently (3); Always (0)

8.0 Do you feel that you are able to give pilots better service using the ACD as compared to the telephone equipment you have used at other FSS locations?

Yes (10). Why?

Lowers noise level in the Operations Room.	(4)
Benefit of queue capability.	(3)
When system works.	(4)
No distraction from ringing telephones.	(1)
Automation is more efficient.	(1)

No (10). Why?

Depends on the number of lost calls.	(2)
System is unreliable.	(4)
With headset, it is hard to hear the calling party.	(3)
Not able to use the Inflight positions to backup Preflight.	(1)
Calling party is, sometimes, connected to two Preflight positions.	(1)

Same (0).

9.0 Is the audio level on the lines to the IN key about right? (5)
Too high? (0)
Too low? (17)

9.1 Is your response to question No. 9.0 generally applicable?

Yes (19); No (2)

If your answer to 9.1 is "no", please explain.

It is frequently necessary to ask the calling party to speak louder and to repeat. (2)

10.0 Is the audio level on the COM key about right? (20)
Too high? (1)
Too low? (0)

11.0 Is the audio level on the ZSE key about right? (20)
Too high? (1)
Too low? (0)

12.0 Is the audio level on the TWR key about right? (20)
Too high? (1)
Too low? (0)

13.0 Would it be beneficial to the Preflight specialist to have the Preflight console modified to include an incoming call indicator for 648-2111 and for each of the foreign exchange lines?

Yes (16). Why?

For system efficiency improvement.	(2)
Call transfer to the Assistant Chief.	(4)
To eliminate requirement to ask for call origin.	(5)
Reduce the noise level in the Operations Room.	(1)
Line usage surveys.	(1)
If call transfer key is not provided.	(2)
Of benefit to maintenance of statistical records.	(1)

No (4). Why?

Would cause unequal workload distribution.	(1)
Need call transfer capability to/from Assistant Chief.	(1)
Does not hurt to ask for information.	(1)
Don't know.	(1)

14.0 When assigned to a Preflight position, do you rarely (12), frequently (7), never (2) forget to use the FLASH key?

15.0 When assigned to a Preflight position, do you use the FLASH key for special reason(s) only? If so, explain.

During inactive periods to check for hung lines.	(1)
To release any one of four FX lines that will not disconnect when the calling party hangs up.	(4)

16.0 After depressing the FLASH key, I sometimes (12), frequently (4), always (2), never (2) discover that the line has not been dropped.

17.0 When assigned to a Preflight position, do you more frequently use the FLASH (8) or RELEASE (12) key to terminate a call that was routed to your console's IN key?

No commentary.

18.0 Do pilots complain less about delays in being connected to a Preflight position than they did a year ago? Yes (3). No (17).

19.0 How frequently are you required to transfer a call from Preflight to:

19.1 Inflight? Never (7); Sometimes (13); Frequently (0)

19.2 NWS? Never (0); Sometimes (12); Frequently (8)

20.0 When you have a requirement to transfer a call from Preflight to Inflight would it be advantageous to the FSS mission to be able to selectively route the call to a specific Inflight position?

No (1). Why? No commentary.

Yes (19). Why?

Because pilot cancelled his flight plan by radio.	(1)
Due forecasted growth statistics.	(1)
Easier for specialist to comply.	(1)
No commentary.	(16)

21.0 Should specialists assigned to a Preflight or Inflight position have the capability to access Hillsboro and/or the foreign exchange lines?

Yes (17). Why?

More efficient service.	(7)
Inflight has requirement due to overdue aircraft.	(6)
Enhancement of FSS mission.	(2)

Coordinate flight plans with Fixed Base Operator and U.S. Customs.	(3)
To provide Inflight backup of Preflight.	(2)
Better workload distribution.	(3)

No (5). Why?

Not necessary.	(1)
Available on 30-key consoles.	(2)
Detracts from primary duties.	(1)
Would serve no purpose.	(1)
Need extra keys.	(1)

22.0 Do you think it better to have the dialer on the Preflight WESCOM console or as a separate unit mounted elsewhere on the Preflight work console?

On WESCOM console (18); Relocated (0). Where? No Opinion (2)

No commentary.

23.0 If you think that the design and utility of the WESCOM Preflight console is not appropriate or is inadequate, please use the following page to rough draw your own idea of a Preflight console.

Only one response: see figure B-1.

Part D: Inflight Position Consoles

1.0 Are the HOLD and RELEASE keys effectively located on the Inflight console?

Yes (23). No (0). Why?

No commentary.

2.0 How often do you use the FLASH key on an Inflight or the EF WESCOM console?

Never (15); Infrequently (4); Frequently (1); Always (1)

3.0 Is the audio level on the ZSE key about right? (21)
Too high? (0)
Too low? (0)

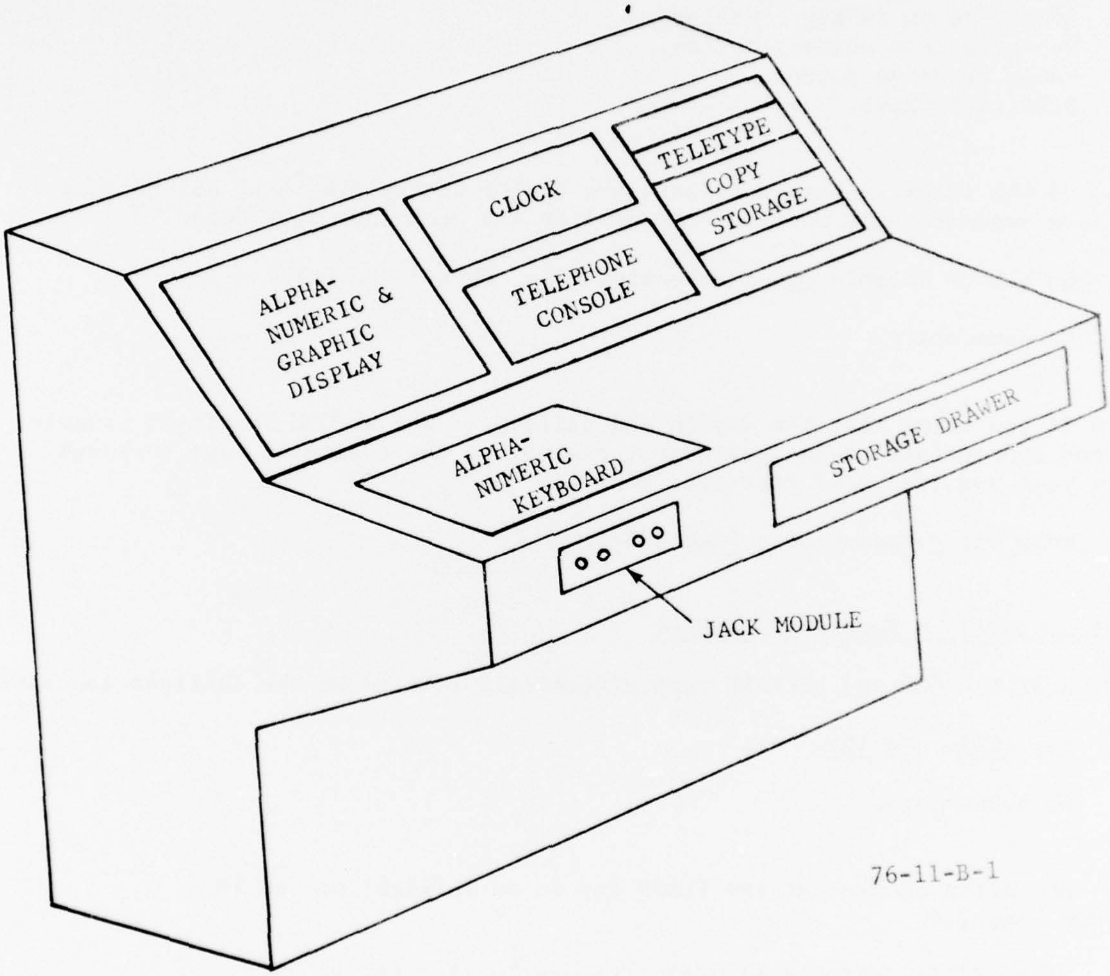

FIGURE B-1. CONCEPTUAL PREFLIGHT CONSOLE

4.0 Is the audio level on the TWR key about right? (21)
Too high? (0)
Too low? (0)

5.0 Is the audio level on the PF keys about right? (17)
Too high? (0)
Too low? (4)

6.0 During your last 5 work days, estimate the number of calls transferred from Preflight to Inflight while you were assigned to an Inflight position.

3 or less (19); 4-6 (1); 7-10 (0); 10-15 (0); 16 or more (0)

7.0 Re your response to question 6.0, do you think there is a cost-beneficial as well as an operational requirement to have more than one PF key in the WESCOM Inflight console?

No (22). Why?

Not used that much.	(8)
Not necessary.	(2)
Only one call transfer can be answered at a time.	(1)
One key is sufficient.	(1)
Inflight position staffing is not sufficient.	(2)
No operational requirement.	(2)

Yes (0). Why?

8.0 Would a unique call alert tone indicating an incoming call to the Inflight position be beneficial?

Yes (15), No (5)

9.0 At the Inflight position, dialing a telephone number is
difficult? (4)
easy? (16)

10.0 Do you usually dial a number while standing? (4)
sitting? (16)

11.0 When assigned to an Inflight position, do you sometimes (2), frequently (1), never (18), always (0) use the FLASH key?

12.0 When assigned to the Inflight position, is there any special reason for using the FLASH key? No (20), Yes (1). Why?

To disconnect from any one of four FX lines. (1)

13.0 Should 648-2111 and/or 648-1022 or a discrete Hillsboro number be accessible from each Inflight position? No (10) Yes (10). Why?

To allow Inflight to provide backup service for Preflight. (5)
To provide better service for overdue aircraft. (7)
Enhance position responsibility. (2)
To contact military-base operations. (1)
To contact Fixed Base operators (1)
So Assistant Chief does not have to perform Inflight duties. (2)

14.0 Do you think it better to have the dialer on the Inflight console or as a separate unit mounted elsewhere on the Inflight work console?

On WESCOM console (18); Relocated (1). Where? No commentary.

15.0 If you think that the design and utility of the WESCOM Inflight console is not appropriate or is inadequate, please use the following space to rough draw your own idea of an Irflight console.

Only one response: see figure B-2.

Part E: 30-Key Consoles and ACD Status Panel

1.0 Re the Incoming Trunk Status Indicators on the ACD Status Panel, please indicate your thoughts by checking one or more of the following items:

(16) Helpful
(1) Not helpful
(2) Indicators are too small
(2) Reflect transient light
(1) Red is an undesirable color. Color should be BRIGHT BLUE.

(2) On a per trunk basis, use a GREEN light to indicate a non-busy trunk and a RED light to indicate a busy trunk.

2.0 Should the trunk numbers 1 - 16 be eliminated by a slotted metal strip into which a line identification tab could be inserted?

Yes (6). No (8)

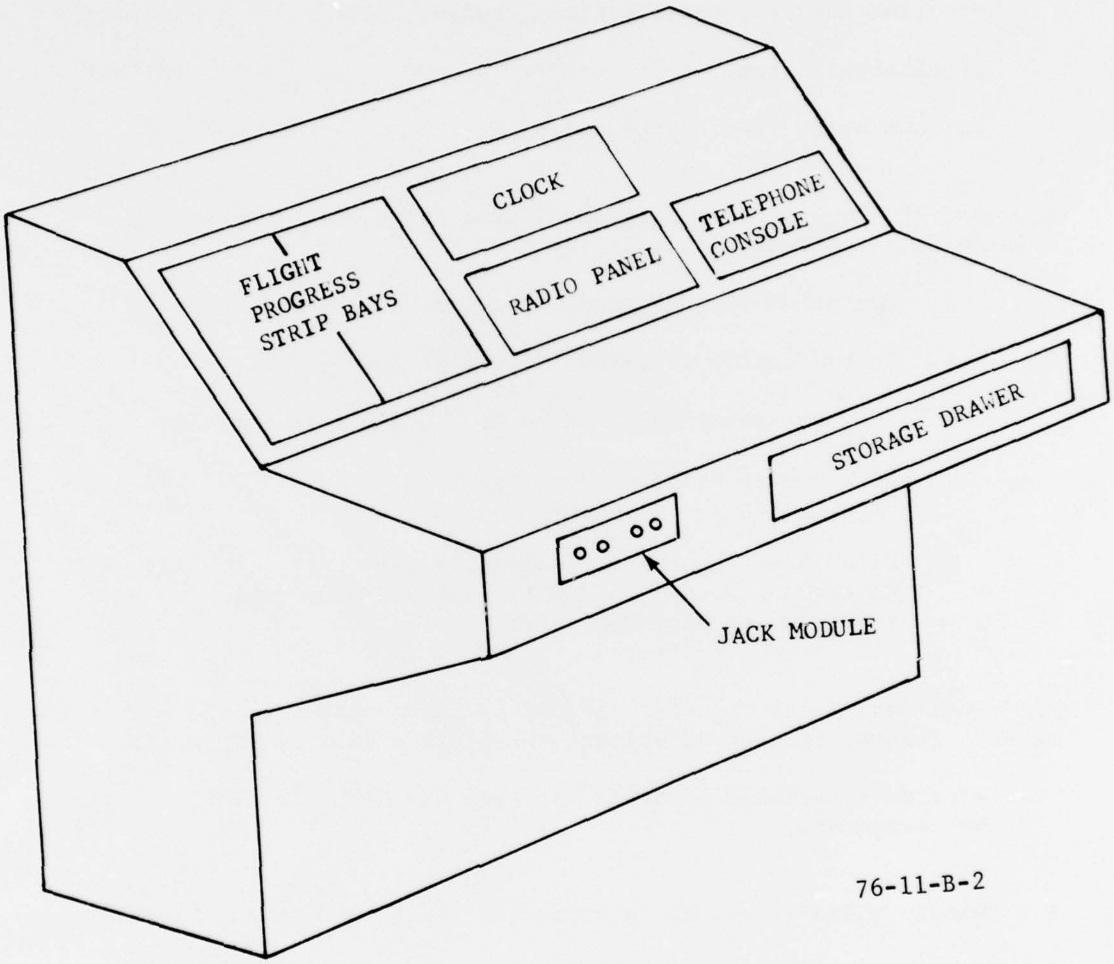

FIGURE B-2. CONCEPTUAL INFLIGHT CONSOLE

3.0 If the Preflight Position Count Registers were manually resettable and kept an accurate count, would you consider using these registers for statistical purposes?

Yes (7). No (5). Why? Unknown (1)

For line surveys, revalidations, budget, etc.	(1)(Yes)
Unreliable system.	(2)(No)

No commentary from 10 responses.

4.0 Are the four system registers (Total Calls, All Trunks Busy, Delayed Calls, and Abandoned Calls)

a. Operationally required? Yes (3); No (8)

b. Statistically required? Yes (5); No (5)

c. If your answer to 4a or 4b is "NO", please explain.

Should have reset capability.	(1)
When system is reliable.	(2)
Pilot briefing number (648-2111) was formerly assigned to Pacific Gas and Electric, thus, we get many PGE calls.	(1)

5.0 What additional registers should be incorporated in the ACD Status Panel? Purpose of such additional registers should be explained.

Provide resettable counters for each CO-FX-PL-FTS line.	(1)
No commentary.	(19)

6.0 Should audio alarms be incorporated in the ACD Status Panel?

No (1). Why?

Present alarm system is adequate.	(1)

Yes (11). Why?

To warn specialist that a line is hung.	(7)
Cannot continuously watch the monitor panel.	(3)
Status lights are easily overlooked.	(2)

7.0 Why would you advocate retention of the six red-lighted Position Status Indicators located below the Position Activity Registers as well as retention of the four PF keys located on the Assistant Chief's 30-key console?

Have limited knowledge of Status Panel.	(4)
Without Preflight status lamps, Assistant Chief would have to patrol the Preflight positions to determine activity.	(3)
Only way to monitor a specific Preflight position.	(3)
Preflight Keys on the Assistant Chief's console effectively add one more Preflight positions.	(2)
It appears one or the other (Preflight keys or status lamps) would be sufficient.	(1)

8.0 Do you consider the Hillsboro and foreign exchange line keys on the Assistant Chief's 30-key console to serve the same purpose as the sixteen Incoming Trunk Status Indicators on the ACD Status Panel.

Yes (10). No (2). Why?

Useful for toll-free outbound calls on FX lines.	(1)
Status lamps on the Panel are a lot easier to see.	(1)
No commentary.	

9.0 Do you think it better to have the dialer on the Assistant Chief's 30-key console or as a separate unit mounted elsewhere on the Assistant Chief's desk?

On 30-key console (13); Relocated (1). Where? Right-hand side.

10.0 If you think that the design and utility of the WESCOM ACD Status Panel is not appropriate or is inadequate, please use the following space to rough draw your own idea of system status panel.

No response.

11.0 If you think that the design and utility of the WESCOM 30-key console is not appropriate or is inadequate, please use the following space to rough draw your own idea of an Assistant Chief's 30-key console.

No response.

11.1 Conceptual idea of a 30-key EF console

No response.

11.2 Conceptual idea of a 30-key Flight Data Console

No response.

Part F: Intercom

1.0 The McIntosh intercom can be used to selectively dial another position within the Portland FSS. However, the connection is not a discrete two-party connection, as any specialist having access to the intercom system can join the ongoing conference by depressing the COM key in his position console. With respect to this information, please check ONE of the following items:

- (2) No commentary.
- (2) Intercom system should be limited to discrete two-party connections.
- (4) Same as above but with the addition of up to four-party conference capability.
- (9) Same as the Portland FSS intercom system.
- (2) Intercom system restricted to administrative, maintenance, and the Assistant Chief positions.
- (2) Not required within the Operations Room.
- (1) Not required within a Flight Service Station building.

2.0 The intercom system does not provide dial tone or ringback signal to the calling party. In addition, the system will cause the called party's phone to ring one time only. Please comment on this feature of the intercom.

Do not understand the statement.	(1)
Bad feature.	(2)
Should ring until answered or until calling party hangs up.	(9)
One ring is sufficient.	(1)
Good, because intercom can be answered at any position.	(1)
All intercom status indicators light - this is sufficient.	(1)
Additional dialing eventually gets someone's attention.	(1)
No commentary.	(7)
Intercom system is required for efficient FSS operation.	(1)
OK the way it is.	(1)
Beneficial between the Operations Room and the administrative positions.	(1)

3.0 How many times have you used the intercom system during your last 5 work days?

Less than 3 times		(13)
4 - 6	"	(2)
7 - 10	"	(1)
11 - 15	"	(1)
More than 15	"	(3)

3.1 If your use of the intercom system during your last 5 work days was any number 15 or less, please comment on the validity of a requirement for an intercom system for interposition coordination within the Operations Room.

Specialists should be educated to use intercom instead of shouting to the other person.	(2)
Intercom should have a discrete ringdown signal.	(2)
Intercom is not required for coordination within the Operations Room and between operating positions.	(4)
Intercom is required for administrative and maintenance positions only.	(1)
Intercom would be used more often if FSS was fully staffed.	(2)
Don't use it too often, but when needed it is beneficial.	(2)
Use of the intercom would cut down on the noise and confusion.	(2)
Intercom not exactly required for our operation but probably will be extensively used due to anticipated growth of our traffic volume.	(1)

Part G: Off-The-Top

If this questionnaire has not drawn out all of your constructive thought and opinion, please feel free to open Pandora's box. Thank you for your time and interest. NO SIGNATURE REQUIRED.

System disadvantages are outweighed by the reduction in noise level.	(1)
Time does not permit proper analysis of this system at this time.	(1)
Sorry, I couldn't answer all of your questions for lack of position experience and lack of talent in (the telephone) art but hope that this is of some help.	(1)
An indicator light should be installed on each Preflight position to indicate when the position has disconnected from a call and is ready to accept another call. As it is now, if a line is hung up there is no indication on the Preflight position.	(1)

This equipment is good on paper and at times, in operation. However, there was not enough testing of field input utilized in this system's design and functions. It should have been thoroughly tested under all conditions prior to installation. It should have had specifications to meet them and have met them. In my opinion, from what I've seen and used, it is not now or do I expect it to be up to the standards we must have, and for the cost's involved, should have. (1)

No commentary. (16)

APPENDIX C

TECHNICAL QUESTIONNAIRE

APPENDIX C

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TECHNICAL QUESTIONNAIRE

Part A: ACD STATUS PANEL DATE: 10-10-75

PURPOSE:

This questionnaire is designed to be completed by the NAFEC technical support team. The majority of the information is to be gathered during the running of script No. 7, "Automatic Call Distribution to Preflight Positions." Script No. 7 will include one subscript specifically designed to test the ACD Status Panel RESET function.

1. When several PF positions are available to take calls, list the order in which the BUSY INDICATORS show the rotation of assignments.

PF No. 4, 1, 2, 4, 1, 2, 4, 1, 2, 3, 4, 1, 2, 3, 4, 1, 2, 3, 4

In-service PF Positions: PF-1, PF-2, PF-3, PF-4

2. Do PF, FD, and EF REGISTERS advance one count per call on incoming trunks?

YES___X___NO________ JUMP________

Other registers advance, sometimes advance on drop and when CALL on No. 4 also advances No. 2.

3. Do REGISTERS advance when receiving a transferred call?

YES________NO___X___

4. Do all trunk status indicators light except 1-4 and 16?

YES Usually________ NO____________IF NOT WHICH All on power failure.

5. Does the abandoned call count advance only if calls are abandoned after the delayed call announcement is started and before a call is taken by a position?

YES__X___ NO______ WHEN? Abandon increase can occur before start of message which takes 2 seconds to audio.

6. Does the delayed call register advance after 3 seconds____ 10 seconds____ 30 seconds__X__ Other: The delay is an adjustable parameter.

7. Does the TOTAL CALLS register advance for each call on an incoming trunk?

YES X NO ___ OTHER: Assistant Chief on duty 10-11-75 reported an advance of 10 when a PF position plugged in his headset.

8. Which light associated with the RESET switch lights on power failure?

P X R ___ When does other light? Did not, but supposed to light when the READ BUS 1 goes to ground or when a trunk fails to transfer through after 500 milliseconds.

9. In the event of power failure and before RESET, what, if any, abnormal operation is indicated on the monitor? Random indication of trunks busy and connected to PF positions, i.e., No. 16 connected to FBO. No trunks dropped.

10. What changes in the ACD Status Panel occur when the RESET switch is pushed?

a. Without power failure: P ___ R ___ OTHER None

b. After power failure: P ___ R ___ OTHER Indicating calls: FBO, 3S2, 1S4, 16. Trunks. PF Positions shown busy but were not Busy. Assignments sequence before RESET - 4, 2, 3, 4, 3, 4, 2, 3, 4, (No. 1 busy).

11. Determine the condition of the BUSY INDICATOR lamps at the ACD Status Panel for the IN key on in-service PF consoles and for intercom and common system keys on each in-service PF console.

IN key: Steady INTERCOM OFF Common Control Subsystem OFF

12. If, after a call is transferred to NWS from a Hillsboro CO trunk and both parties hang-up, does the Hillsboro CO Trunk Status Indicator (Trunk Indicator No. 14) remain in a busy mode?

YES ___ NO X OTHER Note: The Hillsboro CO trunk may not be hung-up if the FLASH key at the PF position were pushed, but the NWS line may hang-up. Release requires that the NWS card be pulled in the equipment room.

13. When an incoming call to a PF position is transferred to NWS while previous calls transferred to IF are in queue, will the NWS call be connected as soon as the NWS trunk is not busy or must it wait until the queue processes the IF transfers? No, there is a separate queue memory for both IF and NWS transfers so there is no delay in transfer of IF calls waiting for NWS or vise versa; thus, there is a separate queue for each.

14. A steady light in the Trunk Status Indicator is for a call being handled.

YES X NO ____ OTHER: Indicators flash only when an incoming call is delayed.

15. At the ACD Status Panel, what are the modes of the Position Indicators relative to the IN key of the PF positions?

Indicator OFF--IN key not depressed or headset not plugged in
Indicator ON--PF position busy with a call.
Indicator Flashing--PF position idle.

16. Complete the matrix for the type and action of each key. Use the following codes: Locking--L, Momentary Contact--M, Interlock Release--R

PREFLIGHT CONSOLES		INFLIGHT CONSOLES		30-KEY CONSOLES	
Key Identifier	Type of Action	Key Identifier	Type of Action		
ZSE	L	PF	L	Line Keys	L
TWR	L	COM	L	SS-1 Keys	L
RAD	L	ZSE	L	RAD Keys	L
NWS	M	TWR	L	WX Key	L
A/G	M	RAD	L	COM Key	L
HOLD	M	HOLD	M	HOLD Key	M
FLASH	M	PF3	L	FLASH Key	M
IN	L	RLS	M	RLS Key	M
WX	L				
COM	L				
RLS	M				

TECHNICAL QUESTIONNAIRE

Part B: POWER FAILURE DATE: 10-13-75

PURPOSE:

This questionnaire is designed to be completed by the NAFEC technical support team. The information required by this test necessitates the shutdown of the system for a brief period. The brief shutdown is to determine the affect on the system upon power failure.

CONDITIONS: PF Positions 1 thru 4 placed in the IN condition. Power failure lamp OFF.

POWER FAILURE: Plug to ACD power supplies pulled for several seconds.

Conditions after power failure:

1. Power failure lamp P ON.

2. Trunk Busy Indicators illuminated in steady mode: FBO, 3S2, 1S4, and 16 none of which had calls on them.

3. PF-1 lamp and trunk No. 16 lamp on ACD Status Panel after other trunks were released.

4. Calls were entered to ACD trunks from the AC and FD positions to determine ACD sequence before RESET. The calls were answered in the following sequence: 3, 4, 2, 3, 4, 3, 4, 2, 3, 4. When PF-1 was flashed, the No. 16 trunk lamp went OFF.

5. A call was entered on the Hillsboro CO trunk and answered on the PF-2 position. The RESET switch was pushed with no affect on call.

APPENDIX D

TECHNICAL INSTRUCTIONS, KR-19 TELEPHONE UNIT ROTARY DIAL INTERCOM

APPENDIX D

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LIST OF ILLUSTRATIONS

APPENDIX D

TECHNICAL INSTRUCTIONS, KR-19 TELEPHONE UNIT ROTARY DIAL INTERCOM

GENERAL.

This instruction covers the installation and maintenance of the KR-19 Key Telephone Unit (KTU).

The KR-19 provides intercom selective signaling capability for any key telephone system using rotary telephone sets. It can be bridged to a TD-508-19 for mixed rotary and tone operation. The KR-19 will not operate from a TOUCH TONE (REG. TRADEMARK OF AT&T) telephone.

DESIGN FEATURES.

The KR-19 KTU:

1. Is a self-contained intercom unit for use with all 1A2 rotary key telephone systems.

2. Provides 19 stations and auxiliary equipment access codes.

3. Signals can be repeated without reoperating the switch hook.

4. Provides one second signal contact closure when the intercom signal is detected.

5. Can be mounted in a key telephone equipment cabinet or directly on the wall.

6. Mates with a standard A25B connector cable.

7. Operates over a voltage range of 18 to 28 V d.c.

INSTALLATION.

No special installation tools are required. Written installation instructions are provided on each unit.

The KR-19 can be mounted in an apparatus cabinet or relay rack equipped with mounting bars arranged for 7-inch Key Telephone Units. If cabinet space is not available, mount the KR-19 directly to a plywood wall with 1/2-inch No. 6 wood or metal screws.

Fasten a female Amphenol ended cable to the KR-19 housing according to the instructions on the unit.

Make cable connections as specified in figure D-1.

Figure D-2 can be used by the installer to field wire a 66B50 terminal block. This wiring method utilizes the standard cutdown of an A25B connector cable. Strapped as shown, the terminal block will provide 19 terminations for T, R, LG, L, B () and R (). All power connections are at the bottom of the block.

COMMON ALL GROUNDS. Leads LG and PC are dry contacts that close when the KR-19 is seized. The contacts can be used to lock a paging circuit or a busy lamp circuit. LG is grounded by the external lamp supply ground.

Do not bridge the intercom to any line supplying a foreign source of current (CO, FX, PL, etc).

Test the lamp operation and signaling for all stations using the system.

MAINTENANCE.

No provision is made for field adjustment or repair.

If no output is detected, verify power connections and fuses. Check Amphenol plug and connector.

Test the system by removing the cable from the back of the KR-19 and connecting it to a substitute unit.

Return defective units to supplier for servicing. Place defective unit in replacement's plastic bag and box. Include cable clamp and add a note describ-fault. Do not deface or write on unit, as this will affect the warranty.

SPECIFICATIONS.

Loop Limits	0-800 ohms
Volts	18-28 V d.c. (21 V d.c. nom.)
Current	.030 amps idle $\pm$.005 amps; .200 amps operated (at 24 V d.c.)
Dial Duty Cycle	40 percent to 80 percent break
Dial Speed	8 to 12 pps
Interdigital Time	Min: 200 ms
Release Time	150 ms + 10 percent from time tip and ring open.
Contacts	250 volts, 2 amps (protected)
Signaling	1-second $\pm$10 percent (in latching mode)
Temperature	0° to 50°C
Dimensions	7 inches x 5.0 inches x 1.5 inches
Mounting	KTU or wall mount
Connection	A25B or equivalent connector cable
Physical Protection	Unit is enclosed in nylon-coated steel housing.

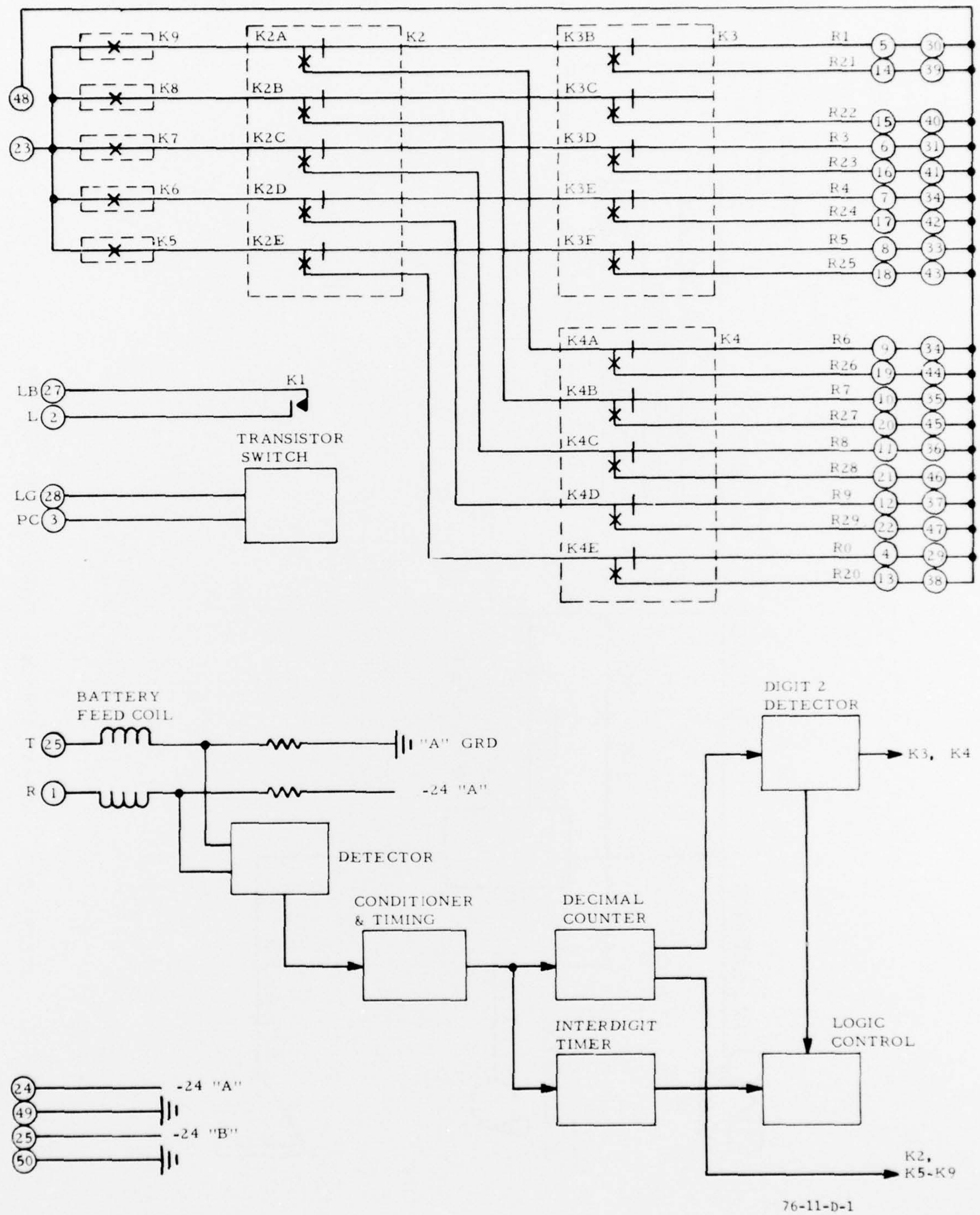

FIGURE D-1. KR-19 CABLE CONNECTIONS

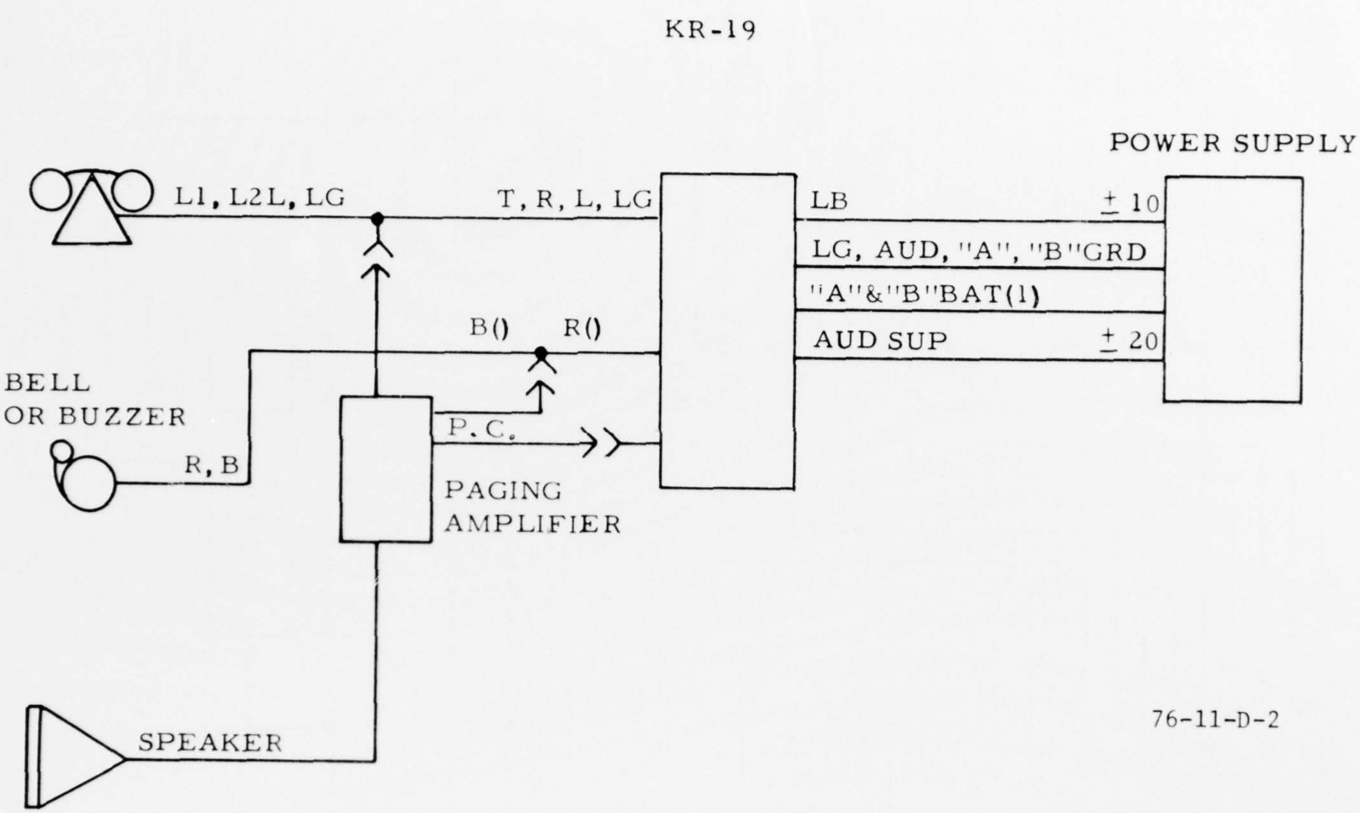

FIGURE D-2. KR-19 TERMINAL BLOCK WIRING DIAGRAM